A Q U A P H Y T E

UNIVERSITY OF FLORIDA
Institute of Food and Agricultural Sciences

CENTER FOR AQUATIC PLANTS

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A "Natural" Sewage Treatment System

Problem: You produce a large recreational event that draws 100,000 people from all over the world for only four days out of the year. This many people produce more than 1 million gallons of waste during four days. Furthermore, your event is isolated from the city--and there are no toilet facilities nearby, not even a Kwik-Gyp store. There are environmental standards for disposing of this waste, and you cannot break the law.

What do you do?

One possible solution is to run wastewater trunk lines from your facility to a municipal treatment system. If you're lucky, then you're close enough so that this would not be too expensive. If you're unlucky, and the nearest connection point is several miles away, then the expense could be several million dollars.

Another solution is to set up a line of portable chemical toilets, which are universally unappealing and incur significant trucking and other disposal expenses.

And another solution is to build a sewage treatment plant on site. However, conventional sewage treatment plants are expensive to build and operate, and they must be continuously supplied with waste in order to "feed the bugs" that break down waste; these systems do not work well with only the occasional "batch loads" of waste produced during your infrequent events.

In real life, the National Hot Rod Association (NHRA) has experienced this dilemma: every year 100,000 thrill-seekers attend Gatornationals, a four-day national drag racing event held in Gainesville, Florida. Until recently, the isolated race track was fully equipped, except for toilet facilities. Now it even has flushing toilets.

NHRA's solution, in close cooperation with the Gainesville Regional Utilities (GRU), was to design and build an innovative "constructed wetlands" for primary, secondary and tertiary sewage treatment. The system is unique because of its ability to accept sudden and heavy untreated waste loads after prolonged idle periods. And unlike the many acres of wetlands used in some places for tertiary wastewater treatment, this entire compact system occupies less than five acres.

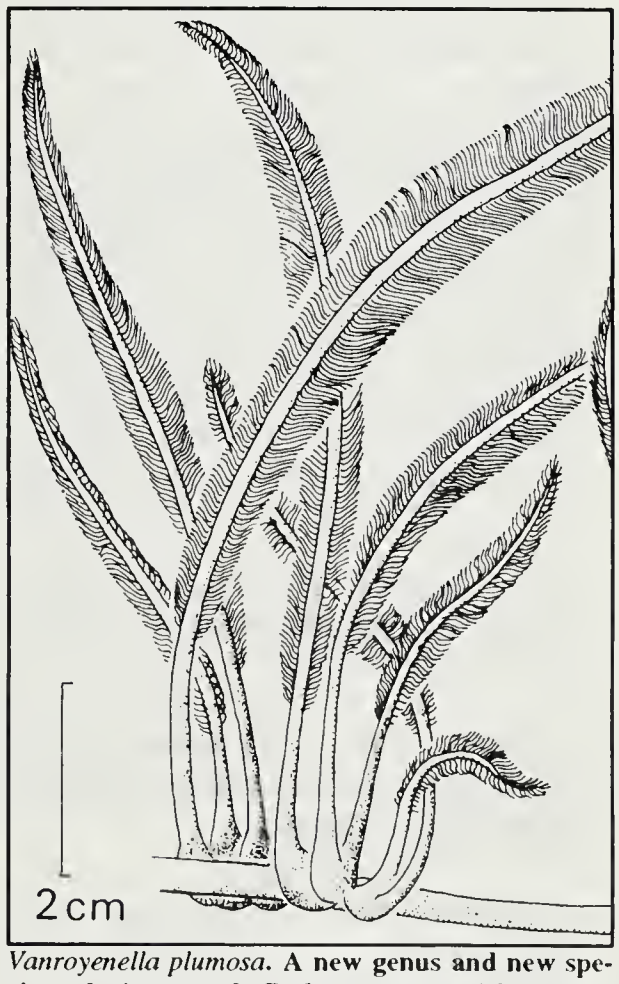
The NHRA/GRU system takes advantage of a new combination of aeration ponds, a gravel denitrification bed, and flow-through ponds filled with aquatic plants for final "polishing".

The resulting treated water meets required environmental standards, and is being used in two ways. Some is diverted for use in on-site fishponds; and some is sent to an automatic sprinkler system which irrigates an on-site pine-tree plantation.

During racing and other recreational events, the system acts as a wastewater treatment plant; during the rest of the year, it acts as an aquaculture farm, capable of supporting the commercial growth of fish, crayfish, shrimp and other freshwater creatures. The aquaculture products and the irrigated pulp-timber can be sold to help pay for the system's overall construction and operating costs.

After two years of operation, the NHRA raceway wastewater treatment system has been declared a success.

[See Waste on Page 4]



Vanroyenella plumosa. **A new genus and new species of river-weed, Podostemaceae. (Used with permission from *Systematic Botany*)**

River-weeds: A Fascinating Family of Aquatic Flowering Plants

by C. Thomas Philbrick[1] and Alejandro Novelo R.[2]

Although river-rapids and waterfalls are not typical habitats for angiosperms, this is where the largest family of strictly aquatic flowering plants abound--the Podostemaceae or "river-weeds". The

[See River-weeds on Page 6]

REWARD OFFERED

Users of the aquatic herbicide Diquat will now be scanning the shelf for a new registered tradename, Reward. Formerly distributed by Valent, the widely used aquatic and noncrop herbicide will now be formulated and marketed by Zeneca Professional Products.

Zeneca is a subsidiary of ICI, the original manufacturers of diquat. Zeneca recently hosted a meeting to discuss the repackaging of diquat. To keep the herbicide steadily available, Zeneca is using the same label as Valent's, except for the new tradename. However, the product is currently undergoing reregistration with the Environmental Protection Agency. Zeneca representatives solicited suggestions for label changes for consideration by the company. Currently the product has both a federal label and a Florida special needs label.

(For product information, contact ZENECA at 1-800-759-2500.)

Workers team up against melaleuca trees in Lake Okeechobee. Another exotic threat to the lake and surrounding wetlands, torpedograss (*Panicum repens*), stretches for miles in either direction.

My Misteak

In the Fall 1992 issue of *AQUAPHYTE*, a sentence under "Melaleuca Biocontrol" on page 1 said that the release of certain insects would be "history's first attempt at managing trees using biological control agents."

An *AQUAPHYTE* reader in South Africa has corrected us. Dr. M.J. Morris of the Agricultural Research Council in Stellenbosch sent us several articles about biocontrol work on exotic trees in South Africa and elsewhere.

He pointed out that four insect species (wasps and weevils) have been released to control *Acacia longifolia, Acacia melanoxylon* and *Paraserianthes lophantha*; and two seed-eating beetles have been released to control the mesquite tree (*Prosopis* spp.).

V.R.

Audubon vs. Melaleuca

In the 1940s, exotic melaleuca trees (*Melaleuca quinquenervia*) were planted by the thousands on the rim canal along the southern levees of Lake Okeechobee, Florida by the U.S. Army Corps of Engineers. The purpose was to control erosion. Now, however, the spreading trees threaten many natural areas of southern Florida, including several sanctuaries leased and managed by the National Audubon Society.

Representatives of the Audubon Society recently initiated and participated in a control effort of this weedy tree in Audubon's 28,000 acre lease around the large lake. A work team was formed that in three days managed to cut down and apply herbicide (Arsenal) to an estimated 5,300 trees, and to hand-pull as many more. They have only three thousand acres to go...

Mr. Ed Carlson, south Florida area manager for Audubon sanctuaries, has had to contend with the detrimental impacts of exotic aquatic plants in this and other Audubon sanctuaries such as Corkscrew Swamp. He states that exotic plant control has to be part of any plan for restoration of an ecosystem, especially in south Florida.

Carlson contacted Ms. Jackie Jordan of the Department of Natural Resources, Bureau of Aquatic Plant Management for a permit to treat melaleuca trees that were moving into shallow waters of the lake. Jordan offered to help and put together a work team comprised of representatives from the Corps of Engineers, the University of Florida, the South Florida Water Management District, the Department of Natural Resources, Asgrow Chemical, American Cyanamid and the Audubon Society.

The South Florida Water Management District and the U.S. Army Corps of Engineers are currently working on a melaleuca management plan for Lake Okeechobee. Ms. Amy Ferriter, Senior Scientific Technician at the district, will head the effort. Ferriter's recent work with remote sensing and GIS helped document the rapid expansion rate of melaleuca in south Florida. As a result, her project won a SWIM grant of $200,000. (SWIM is Florida's Surface Water Improvement and Management Act.)

A T T H E C E N T E R

Videophile

Two more video programs have been released by the Center for Aquatic Plants, bringing the total number to some 15 productions relating to aquatic plants and their management. They are:

Maintenance Control Of Aquatic Weeds--What It Is Not!

1993, 12 minutes.

This program presents the concept of maintenance control, "the most environmentally sound and economical method of aquatic plant management." Joe Joyce, Ph.D., explains how it reduces management costs, herbicide use and overall impacts of aquatic weeds and their management.

Florida Lakewatch--Join The Team!

1993, 10 minutes.

This program describes Florida *LAKEWATCH*, a program wherein citizen volunteers regularly take water and algae samples, and Secchi disc readings in an effort to track the water quality changes of lakes and rivers. The samples are analyzed at the University of Florida Department of Fisheries and Aquatic Sciences, and the resulting data are made available to volunteers and state resource management agencies.

Other video programs from the Center

Florida's Aquatic Plant Story

What Makes a Quality Lake?

Istokpoga--Lake of Legends

Calibration--A Field Approach

How to Determine Areas and Amount of Aquatic Herbicide to Use

AQUATIC AND WETLAND PLANT IDENTIFICATION SERIES:

- **Floating and Floating-Leaved Plants**
- **Emersed Plants - Part I**
- **Emersed Plants - Part II**
- **Submersed Plants - Part I**
- **Submersed Plants - Part II**
- **Grasses, Sedges and Rushes - Part I**
- **Grasses, Sedges and Rushes - Part II**

Programs **may be borrowed** from the Information Office (904/392-1799). Or they **may be purchased** from IFAS Publications, Building 664, Gainesville, FL 32611 (904/392-1764) for $15.00 (plus .90 tax for Florida residents), payable to the University of Florida. Checks or purchase orders are accepted. Specify VHS or European PAL format.

Welcome Back!

We are pleased to announce that *AQUAPHYTE* once again is available to subscribers overseas. We look forward to sharing information with our more than 1,000 friends in other countries. Please keep us advised of address corrections or of colleagues who may wish to receive the newsletter.

Remember to share your work with the readers of *AQUAPHYTE* by contributing reprints to the **APIRS** database. See *FROM THE DATABASE*, page 8-11.

APIRS Update

From approximately 5,000 records ten years ago, the Aquatic Plant Information Retrieval System (**APIRS**) has grown to a collection of more than 34,000 records. They include books, articles, abstracts, proceedings, management plans, and now, videos.

APIRS spans all types of research including plant physiology, taxonomy, weed control methods, utilization as animal feed or pollution control, restoration of freshwater ecosystems, constructing wetlands for wastewater treatment, aquascaping, value as wildlife habitat, and more.

Last year, more than 700 searches of the database were performed for a yield of almost 51,000 citations. Hard copies of 95% of all records are on file in the **APIRS** library.

Searches of the **APIRS** database continue to be provided free of charge, but with the expectation that reprints and publications lists will be contributed in exchange.

We encourage researchers throughout the world to contribute reprints or photocopies of their work for inclusion in the **APIRS** collection.

Aquatic Plant Drawings

Do you need line drawings of aquatic plants to enhance a report, book or journal article or to illustrate a pamphlet, sign or display? Line drawings of over 60 aquatic plants are available from the **APIRS** Office of the Center for Aquatic Plants. A set of the entire collection of illustrations can be provided, or drawings of specific plants may be requested. The botanical illustrations may be used for educational or scientific purposes only. (Commercial use is prohibited.) The drawings are provided free of charge. However, in exchange, users are requested to submit any publications in which the drawings are used. Full acknowledgement is required.

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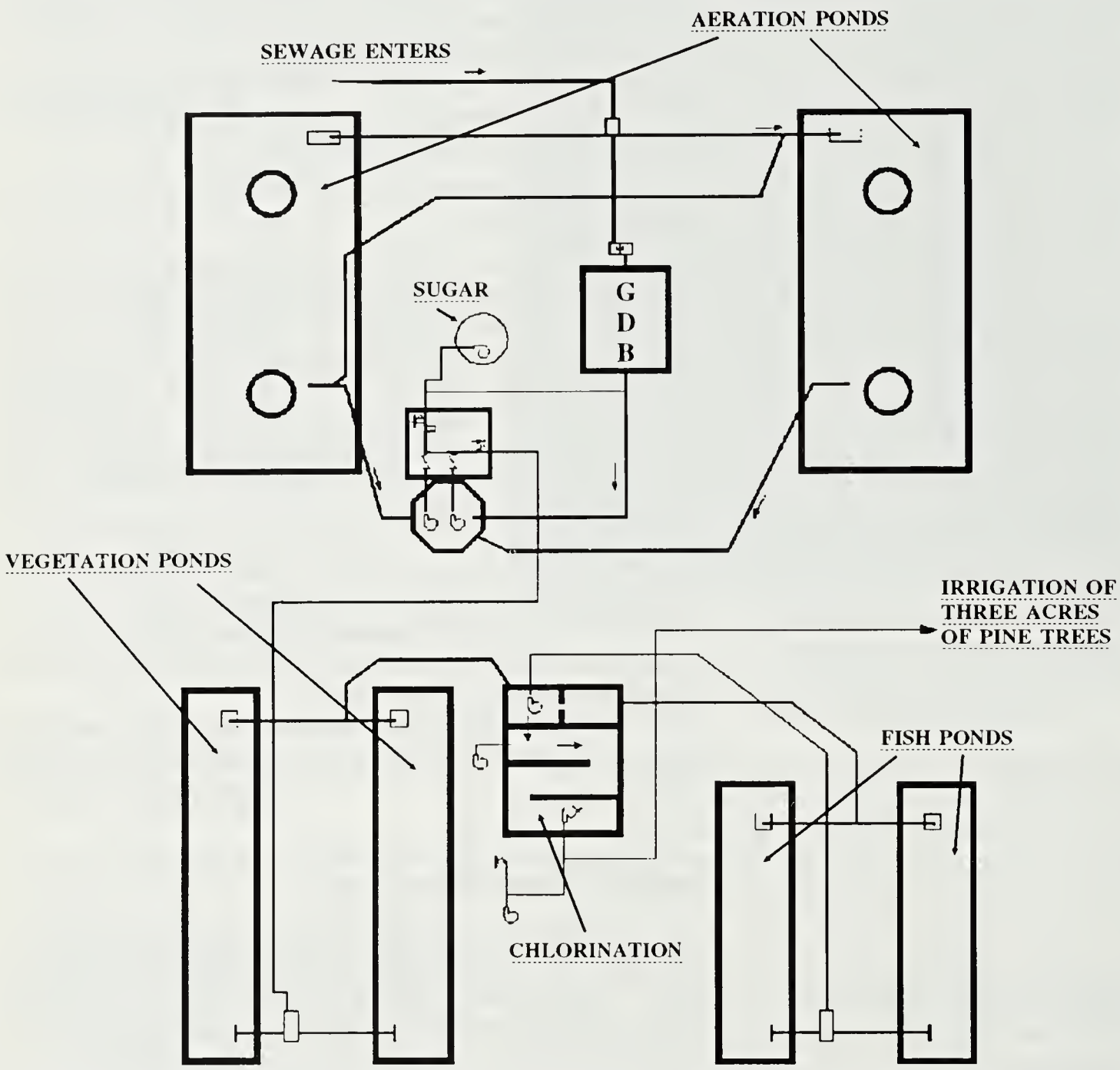
Dr. Joseph Joyce, Director

[From Waste on Page 1]

The aquaculture part of the system was designed and built under the guidance of researchers Dr. Jerome Shireman and Douglas Colle, and visiting Polish fisheries experts, husband and wife Drs. Karol and Wanda Opuszynski, all of the Department of Fisheries and Aquatic Sciences of the University of Florida.

The Site

The compact five acre treatment facility operates in four phases, and releases treated water on site.



Simplified schematic of the Gainesville Raceway Water Reclamation Facility. Raw wastewater is pumped from the restrooms to the aeration lagoons, to the gravel denitrification bed, and then to the aquatic plant filtration ponds. Polished water is then diverted to aquaculture fish ponds, or to an irrigation system being used to grow pine trees. Cultured fish and pine trees may be sold to offset overall wastewater treatment costs.

Phase 1 (Gatornationals phase)

During this phase, a primary objective is to minimize odors by supplying oxygen by aeration. During racing events, untreated wastewater flows from restrooms into the 1/2-acre lagoons, which are equipped with large floating aeration pumps. The aerators are turned on and allowed to run continuously. During this phase, much of the organic matter in the wastewater is metabolized by bacteria, but little nitrification is accomplished.

Phase 2 (Nitrification phase)

During this phase, ammonia in the wastewater is oxidized to nitrite and then to nitrate. Continuing aeration increases the population of and suspends waste-eating bacteria (*Nitrosomonas*), and helps remove total suspended solids (TSS) and reduce biological oxygen demand (BOD). (BOD is the amount of oxygen consumed by bacteria as they convert and use the organic waste materials.) During this phase, too, water alkalinity is reduced to levels safe enough for fish.

Phase 3 (Denitrification phase)

Denitrification is carried out in the gravel denitrification bed (GDB). During this phase nitrite and nitrate in the water are converted to nitrogen gas, which disappears into the atmosphere. Sugar is injected into the wastewater to establish and maintain high bacterial populations for the denitrification reactions.

The GDB is a plastic-lined pit filled to a five foot depth with 1-inch diameter gravel. In the GDB, water is fed to the bottom of the bed, and is distributed throughout the bottom by a network of pipes. The water percolates *upward* through the rocks and drains at the top. The water is circulated between the GDB and the aeration lagoons until bacterial action has reduced the ammonia nitrogen to below 1.0 mg/l and the total nitrogen to less than 10 mg/l.

Phase 4 (Polishing phase)

In this phase, treated wastewater is drained from the aeration lagoons into two long, narrow, flow-through aquatic vegetation ponds. One pond is filled with the submersed plant, hydrilla (*Hydrilla verticillata*), the other is covered over with the floating plant, duckweed (*Lemna* spp.).

In these ponds, the already treated wastewater is "polished" for use as "make-up water" in the adjacent aquaculture ponds and for ultimate release into the raceway's spray irrigation system.

One purpose of the vegetation ponds is to further reduce the suspended solids (TSS) of the wastewater. This is accomplished mainly by the hydrilla, where the large leaf surface area of the submersed plants act as a natural filter and provides much more substrate for the beneficial wastewater cleansing bacteria.

Another purpose of the vegetation ponds is to reduce the nitrogen and phosphorus in the wastewater. The constantly growing aquatic plants utilize nutrients, and greatly reduce nutrient availability to algae. Reducing algal density makes the water much clearer.

Aquaculture Ponds

For thousands of years, Oriental cultures have been using human and animal wastewater to culture fish and other food animals. Shireman and his researchers say their system is simply a more modern version of this age-old, completely safe and efficient way of growing food.

While finishing the wastewater to required standards, the aquatic plants are regularly harvested and fed to the plant-eating fish being grown in the aquaculture ponds. Harvesting the plants promotes their biomass production, thus further increasing their efficiency for cleansing wastewater, and making more plants available for aquaculture production.

In the present case, the fish being grown are grass carp (*Ctenopharyngodon idella*), which in Florida are used for aquatic weed control, and which elsewhere are used for food. Hydrilla is a favorite food of grass carp, and duckweed is a perfect size for growing fingerlings. In addition, blue tilapia and bighead carp have also been raised in these ponds.

However, there is no reason to limit aquaculture to these kinds of fish--other fish may be grown for food or re-stocking programs, or other freshwater animals such as shrimp or crayfish may be cultured.

Results

Costs

The construction cost of the present facility, approximately $340,000, was less than one-third that of a conventional system of the same size. In addition, there are no high on-going costs for continuous operational preparedness or for full-time personnel. Operating costs have been estimated at approximately $12,000 per year.

Water Quality Standards

The finally polished water which is disposed of on-site to grow a pine plantation exceeds the standards required by the Florida Department of Environmental Regulation (FDER). These requirements are 20 ppm BOD, 20 ppm TSS, or 90% removal, whichever is greater; and 12 ppm ammonia nitrogen. Chlorine is applied before release to reduce the fecal colliform to less than 100/mL.

Aquaculture Value

The grass carp grown in the fish ponds may be sold in Florida for aquatic weed control. At the common sales price of $6 for a (10-inch fish), the value of the fish grown in these ponds has been estimated at $24,000 per hectare.

The system has worked well during two Gatornational events, each of which produced "batch loads" of more than 1 million gallons of wastewater during the four days of races. By all measures, this unique and compact "natural" wastewater treatment system must be judged a success.

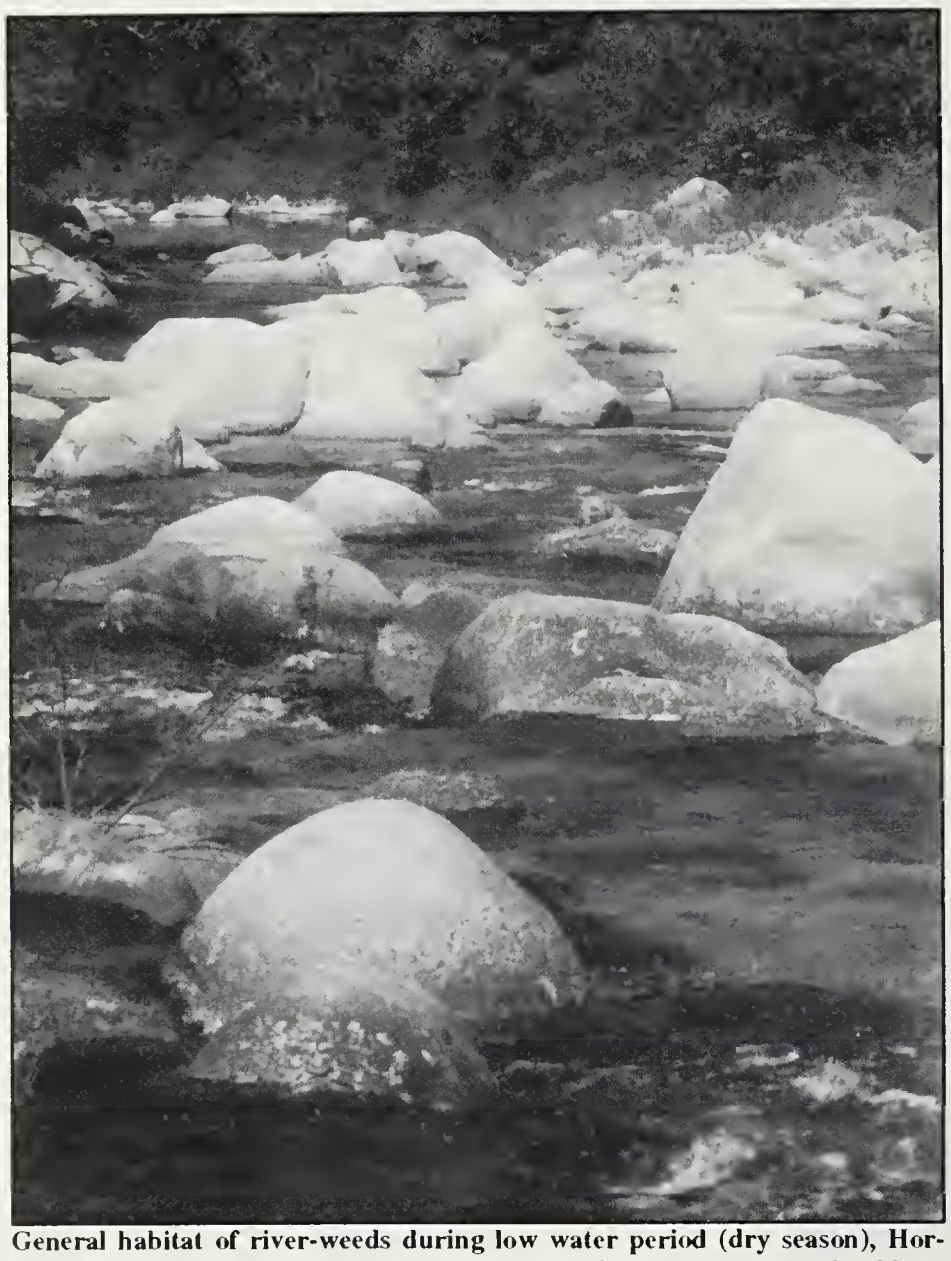
For more information on this "constructed wetlands" system, contact Dr. Jerome Shireman, Department of Fisheries and Aquatic Sciences, 7922 NW 71st Street, Gainesville, Florida 32607, (904) 392-9617.

Chemist Dr. Wanda Opuszynska, takes one of her last water samples at the raceway before returning to her native Poland.

[River-weeds, From Page 1]

ecology of river-weeds stimulates the imagination. Plants grow tenaciously attached to rocks and other solid substrata in rushing torrents of tropical river-rapids and plummeting waterfalls. However, although a few general accounts of their seemingly bizarre morphology, anatomy, and modes of reproduction are available, virtually nothing is known in way of detail for any of the species. In fact, understanding of basic biology of these fascinating plants could provide valuable insight into the evolution of aquatic plants in general and man's impact on the aquatic environment.

In contrast to most other families of strictly aquatic flowering plants that possess at most 17 genera and seldom more than 30 species, the river-weed family contains 48 genera and 268 species. River-weeds have adapted well to, and fluorish within, this extreme aquatic habitat.



General habitat of river-weeds during low water period (dry season), Horcones River in Jalisco, Mexico. Plants occur on these large granitic boulders.

Podostemaceae are pantropical. Few species occur in temperate regions. *Podostemum ceratophyllum* occurs in eastern United States and Canada and is the only temperate New World species. Thus, it is not surprising that aquatic biologists in North America typically know little of the family.

General life history features of river-weeds reflect the nature of the seasonal habitat in which they occur. River-weeds primarily occur in rivers that have a distinct seasonality; high water levels followed by a low flow period. Vegetative growth takes place during the period of high water when the plants are submersed. River-weeds occur in areas of direct sunlight and well aerated water. Plants grow attached directly to solid substrata (typically rocks) by means of adhering roothair-like rhizoids and fleshy expanded holdfasts termed "haptera". Mature plants are submersed in the swiftly moving water, from which they derive nutrients and dissolved gasses. Podostemaceae do not fit the classical root-shoot model typical of most flowering plants. More akin to the seaweeds, the prostrate axis (the "root") serves primarily as an anchoring organ and seems to play no role in nutrient or water uptake.

Only after the water level drops does flowering take place. Flowering is distinctly aerial and both wind and insect pollination have been reported. The capsular fruit of river-weeds requires desiccation to dehisce. Seeds are initially shed passively onto the rock. Water dispersal is a likely mode of subsequent transport of seed, although dispersal between river systems has also been attributed to birds.

The seed and seedling attachment stages seem especially vulnerable periods in the life cycle of river-weeds. A protective covering of soil or leaf litter that is directly linked to the seed biology of most angiosperms is lacking. For a river-weed plant to become established from seed, two critical attachment phases must occur. First, a seed must attach to, and germinate upon, the surface of a rock. This is accomplished via the outer rather mucilaginous layer of the seed coat. When hydrated, these cells expand, and upon drying adhere the seed firmly to the substratum. Successful attachment of the seed seems most likely when the rock is dry (low water period). Secondly, the seedling must become established. The seed germination and seedling attachment phases occur when the water level is high, i.e., in rushing current. Immediately after germination the projecting seedling bends toward the rock and the apex flattens against it. Elongate extensions of the epidermal cells of the seedling radical secrete a substance ("podosto-grip"!) that affixes the seedling.

Inadequate collections in herbaria are a central problem in dealing with the taxonomy of river-weeds. Species are generally represented by few, or often only one, collection from large geographic areas, and those specimens that are available are often incomplete. It seems that the life cycle of these plants has been a major hindrance to developing adequate collections. An additional factor seems to be the general lack of inclination of botanists to visit river-rapids in search of plants. Clearly a concerted effort is needed to collect complete specimens. Maximum vegetative growth of river-weeds is when the plants are submersed, thus the largest leaves are collected prior to flowering. However, when plants are exposed, and flower, the mature leaves are often shed. Smaller secondary leaves may be produced subsequently, often with a markedly different appearance. Finally at the time of mature capsule formation the leaves have long since died back. Thus it is necessary to visit a population repeatedly or for a duration of several weeks to collect all phases of the life cycle. All phases are needed for the most meaningful taxonomic work.

Numerous authors have noted the high level of endemism in the river-weeds, i.e., species that occur in only a single set of river-rapids or a single river. The species in the new world illustrates this nicely. From P. Van Royen's early 1950s treatment, it is evident that 14 of the 19 genera contain endemic species. About 48% of all new world species are endemic. However, because of

the need for taxonomic work it is unclear what proportion of the endemism is real versus taxonomic artifact. Here too, the inadequate collections of specimens is a hindrance to interpreting the significance of the purported levels of endemism. Are endemics actually more widespread, or perhaps environmental forms of other species? These questions cannot currently be addressed.

Moreover, a range of intriguing evolutionary questions must wait to be addressed until the taxonomic framework is better established. For example, how has the unidirectional flow of the medium in which river-weeds grow affected gene flow? How is gene flow affected upstream, or between drainage basins? What role has habitat versus biological factors played in speciation? The river-weed family also provides an opportunity to test evolutionary theory, i.e., the overall paradigm that predicts slow evolutionary rates, and thus small taxonomic size, of aquatic angiosperm groups. Why are there so many species of river-weeds? What role does the strong attachment of the plant to the substratum play? The high degree of flowering of most river-weeds also contrasts markedly with the low incidence of flowering of many aquatic plants. What significance is this to the evolution of the group? We must know what the bounds are between species in order to address these questions.

From a conservation perspective it is most prudent to assume that the high level of endemism in river-weeds is real until additional evidence suggests otherwise. Given that high levels of endemism and conservation typically go hand in hand what are the current and projected conservation concerns for river-weeds? This is unclear. Rivers are utilized heavily by people and represent the most heavily polluted of tropical aquatic habitats (Sioli 1986). As human populations increase and development continues in tropical regions so will utilization of rivers for domestic, industrial and agricultural needs. These activities are likely to have detrimental impacts on river- weeds via pollution, water level manipulation, and siltation from construction and agriculture.

Even though little ecological work has been done on river-weeds it is evident that they are sensitive to water pollution. For instance, populations of *Podostemum ceratophyllum* in New Hampshire were decimated after apparent industrial water disposal in the early 1970s (Philbrick & Crow, 1983). Pollution associated with coffee plantations may have lead to the extirpation of *Podostemum riciiforme* at the type locality for the species in Veracruz, Mexico. Domestic sewage is a likely cause for the demise of two species of river-weeds in the Mexican state of Morelos. Herbarium records indicate that species of *Marathrum* and *Tristicha* occurred in rivers in Morelos as recently as the mid 1970s, although recent field work in these now polluted rivers suggests both have been extirpated.

Siltation is a particular concern. Siltation increases turbidity, decreasing available light for submersed plants. A layer of silt deposited upon the rocks will likely be detrimental to the intial attachment of the seed and subsequently the seedling. Grubert (1974) has shown that seedlings of Venezuelan species are most apt to be washed from the rock by the current during the initial seedling attachment. Studies of Mexican river-weeds have led us to the same conclusion.

It may be possible for aquatic resource managers in tropical regions to use river-weeds as biological indicators of water quality. However, comparing scanty historical records against current distribution patterns can only suggest their potential in this regard. We are hopeful that comprehensive records compiled from ongoing studies can contribute to a database to help assess changes in water quality in the future. Of course, detailed physiological studies would be needed to define sensitivities of particular species. Biological indicators of this sort could serve as a valuable low-cost means of quickly assessing water quality in tropical rivers.

Close-up of *Vanroyenella plumosa* plant attached to a granitic boulder. (Swift current running over the plant makes difficult the photography of the plant.) The leaves of this species are long and feather-like.

The Podostemaceae are a fascinating group of aquatic plants that begs the attention of aquatic plant biologists. From an evolutionary perspective, the family remains enigmatic. Issues ranging from the ancestral origin of the family within terrestrial groups, to the ecological and biological factors resulting in the remarkable radiation in such an extreme aquatic environment, remain unexplored. From a conservation or wetland management perspective, river-weeds may hold special promise as biological indicators. Indeed, the habitats that river-weeds occupy, river-rapids and waterfalls, should be viewed as a unique form of tropical wetland with an unique flora (and fauna) and concomitant conservation issues. However, an appreciation of this unique habitat can only be attained after we achieve some degree of understanding of the biota that occur there. This is currently lacking.

[1] Rancho Santa Ana Botanic Garden, 1500 N. College Avenue, Claremont, California 91711.

[2] Departamento de Botanica, Instituto de Biologia, Universidad Nacional Autonoma de Mexico, D.F. 04510.

FROM THE DATABASE

Here is a sampling of the research articles, books and reports which have been entered into the aquatic plant database since November, 1992.

The database has almost 35,000 items. To receive free bibliographies on specific plants and/or subjects, contact APIRS at the address shown on the mail label on page 16.

To obtain articles, contact your nearest state or university library.

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BOOKS/REPORTS

THE MURRAY edited by N. Mackay and D. Eastburn, Murray Darling Basin Commission, Canberra, Australia. 1990. 363 pp.
(Order from CSIRO Publications, P.O. Box 89, East Melbourne, Victoria 3002, AUSTRALIA. US$35.00 + 10% postage/handling.)

The United Nations definition of "sustainable development" is that it "meets the needs of this generation without making it difficult or impossible for future generations to fulfill their own needs."

This well-produced full-color book is about the sustainable development of the River Murray of South Australia. The Murray Basin provides water to 90% of the population and comprises the "agricultural heartland" of the state.

The book compiles information from diverse scientific papers and technical reports about the basin. It contains everything about the river, from the geology of its headwaters to the history of its channels, from its water chemistry to the distribution of plants and animals along its 2,500 km length.

We have not seen such a complete, handsome and readable treatment about any other water body, anywhere.

VEGETATION OF INLAND WATERS edited by J.J. Symoens, Kluwer Academic Publishers, Norwell, Massachusetts, 1988. 385 pp.
(Order from Kluwer Academic Publishers, 101 Philip Drive, Norwell, Massachusetts 02061. US$162.50.)

This book being one volume in the Handbook of Vegetation Science series, it contributes to a "better understanding of the environmental conditions offered to plant life by inland waters, of the characteristics and adaptations of the plants which colonize the latter, and of the structural and functional features of their plant communities." The book features 11 articles by the world's best known aquatic plant researchers.

NATIONAL LIST OF PLANT SPECIES THAT OCCUR IN WETLANDS, A Field Guide, edited by B.J. Sabine, Resource Management Group, Inc. 1992, various pages.
(Order according to US region, from Resource Management Group, Inc., P.O. Box 487, Grand Haven, MI 49417-0487. (616) 847-1680. US$15 + $2 shipping/handling.)

These guides are regional versions of the *National List of Scientific Plant Names.* Each guide includes in alphabetical order the scientific names, common names and the indicator status for each wetland plant species.

TOXIC BLUE-GREEN ALGAE, a report by the National Rivers Authority, London. 1990. 127 pp.
(Order from National Rivers Authority, Kingfisher House, Goldhay Way, Orton Goldhay, Peterborough PE2 5ZR, United Kingdom. 15 pounds sterling, including postage/handling.)

During the late summer of 1989, dogs and sheep living around a large public water reservoir in England began to die. Authorities quickly traced the deaths to *Microcystis aeruginosa,* a toxic blue-green algae. A few days later two soldiers were hospitalized with serious symptoms. They had been canoeing and swimming in another lake, and were stricken by the same toxic algae.

As a result of these well-publicized episodes, the National Rivers Authority commissioned a report about toxic blue-green algae. This report is "the first major appraisal of the subject as a whole within the UK."

Included in the report are chapters about algae blooms and toxicology, and about the influence of nutrients and biotic factors on blooms. Also included are chapters about algae control and management, and about research thrusts and recommendations. It is a thorough review of what is known about toxic blue-green algae.

THE RIVERS OF FLORIDA edited by R.J. Livingston, volume 83 of Ecological Studies, Springer-Verlag, New York. 1991. 289 pp.
(Order from Springer-Verlag New York, Inc., P.O. Box 19386, Newark, NJ 07195-9386. $65.00.)

"This book addresses basic questions concerning the ecological relationships and current conditions of the major river systems in Florida." The 13 chapters include general information about the physical environment of rivers, how tidal rivers work, and the plants and animals found in various rivers. Also included are chapters dealing specifically with the Oklawaha River, the St. Johns River, the Everglades, the Lower Peace River, the Apalachicola and the Choctawhatchee.

This book is an excellent source of data and references about all aspects of the rivers of Florida.

BIOLOGICAL CONTROL OF PISTIA STRATIOTES L. (WATER LETTUCE) USING NEOHYDRONOMUS AFFINIS HUSTACHE (COLEOPTERA: CURCULIONIDAE) by F.A. Dray, Jr. and T.D.Center, Aquatic Weed Research Laboratory, Fort Lauderdale, Florida. Technical Report A-92-1. 1992. 62 pp.
(Order from USAE Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199. Technical Report A-92-1.)

This final report describes the "impressive" success of the water lettuce weevil in controlling water lettuce infestations at two south Florida sites. Results at a third site were not so impressive.

At one success site, 1,600 weevils became 42 million weevils within two years, completely eliminating 10 acres of water lettuce. At another, 69,000 weevils became 45 million within one year, reducing a water lettuce infestation from 50 acres to less than 5. At the not-so-successful site, 6,600 weevils never became more than 84,000 during two years, and had little impact on the plants.

CRITERIOS BOTANICOS PARA LA VALORACION DE LAS LAGUNAS Y HUMEDALES ESPANOLES (PENINSULA IBERICA Y LAS ISLAS BALEARES) by S.Cirujano Bracamonte, M. Velayos Rodriguez, F. Castilla Lattke and M. Gil Pinilla, Consejo Superior de Investigaciones Cientificas, Madrid, SPAIN. 1992. 456 pp. (In Spanish)
(For ordering information, contact Dr. Santos Cirujano Bracamonte, CSIC, Real Jardin Botanico, Plaza de Murillo, 2.28014, Madrid, SPAIN.)

The purpose of the book was to collect "basic botanical criteria to assess our wetlands." It lists all "trustworthy" references to the aquatic plants of the wetlands, ponds and lakes of the Iberian Peninsula and the Baleares Islands. It includes an extensive bibliography and indexed plant lists for 444 major lakes and wetlands. The authors recognize lakes and wetlands of national and European importance.

CONSERVATION AND MANAGEMENT OF LAKES edited by J. Salanki and S. Herodek, Balaton Limnological Research Institute, Tihany, HUNGARY. 1989. 645 pp.
(Order from Akademiai Kiado Publishing House, Prielle Kornelia U. 19-35, H-1117, Budapest, HUNGARY. US$64.00.)

This book includes fifty selected papers from the Third International Conference on the Conservation and Management of Lakes ("Balaton '88"), held in Keszthely, Hungary, 11-17 September 1988, sponsored by the United Nations Environment Programme (UNEP) and the International Lake Environment Committee (ILEC).

Papers are included in the following sections, followed by case studies: Eutrophication and its Control, Acidification and Toxic Pollutants, Lake Protection Over the World, Management of Shallow Waters, and Lake Management as an Ecological, Economic and Jurisdictional Complex.

(Among the papers is an excellent review of the concept of eutrophication by R.A. Vollenweider, the author of one of the most widely used models in all science.)

BRIOFITOS ACUATICOS DEL RIO IREGUA (LA RIOJA) by J. Martinex Abaigar and E. Nunes Olivera, Instituto de Estudios Riojanus, 1991, 222 pages. In Spanish.
(Order from Ediciones Instituto de Estudios Riojanos, Logrono, SPAIN.)

Aquatic bryophytes live in the water, often in shaded streams and creeks. They include mosses such as *Fontinalis* spp. and liverworts such as *Riccardia* spp. Bryophytes may be attached to rocks and logs, or may be free-floating streamers.

This book is all about the bryophytes of the Iberian peninsula. It includes a catalog and distribution maps and discusses the geology and water chemistry of the rivers in which they live. Also included are studies on the photosynthesis of bryophytes, their pigment composition, and effects of pollution on bryophyte growth. It is completed with an extensive bibliography of the worldwide literature.

WETLANDS MANAGEMENT IN THE CARIBBEAN AND THE ROLE OF FORESTRY AND WETLANDS IN THE ECONOMY, edited by A.E. Lugo and B. Bayle, US Dept. Agr. Forest Serv. So. Forest Expt. Stn, (New Orleans), 1992, 115 pages.
(Order from US Department of Agriculture, Forest Service, Southern Forest Experiment Station, Room T-10210, USPSB, 701 Loyola Avenue, New Orleans, LA 70113. Free.)

This is the proceedings of the Fifth Meeting of Caribbean Foresters at Trinidad, May 21-26, 1990, and the Meeting of Ministers of Agriculture to Consider the Economic Role of Forestry at St. Lucia, July 5-6, 1990.

The publication has three sections: a listing of findings, recommendations and resolutions of the two meetings; a section on contributed papers to the meetings; and appendices and list of participants.

Included are papers on wetlands in Antigua, Barbuda, Dominica, Grenada, Guadeloupe, Jamaica, Martinique, Montserrat, Puerto Rico, Saint Lucia, Saint Vincent and the Grenadines, Caroline Islands, and Trinidad and Tobago.

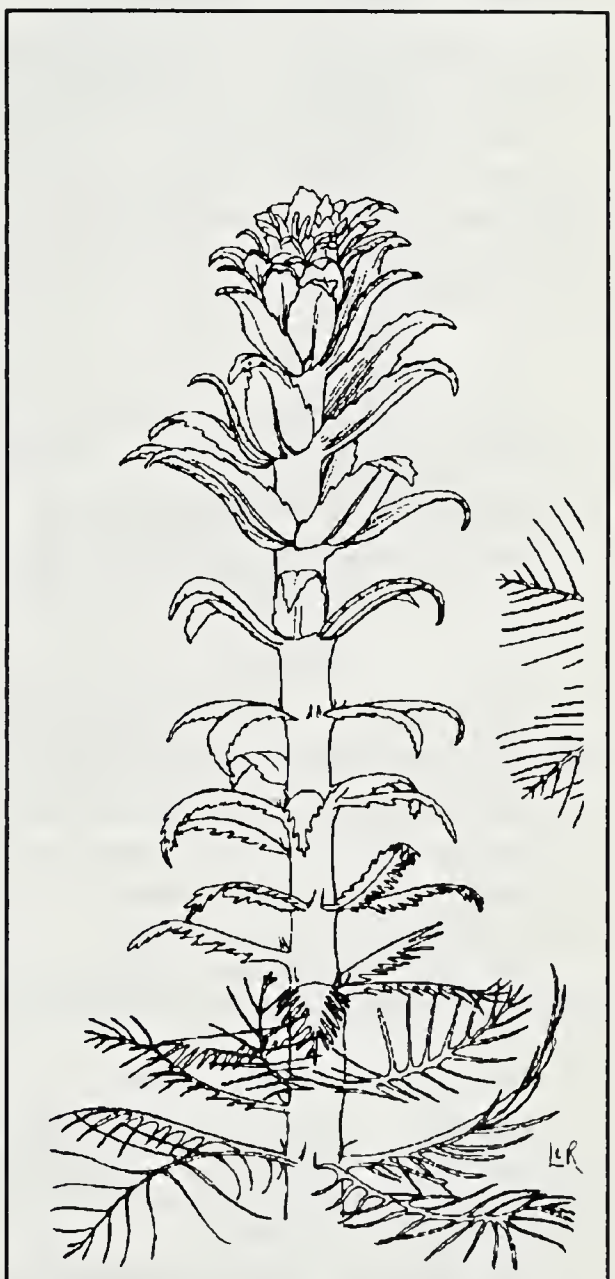
SEDIMENT TOXICITY ASSESSMENT, edited by G.E. Burton, Jr., Wright State University, Dayton, Ohio, 1992, 457 pages.
(Order from CRC Press, Inc., Lewis Publishers, 2000 Corporate Blvd. N.W., Boca Raton, FL 33431, (1-800-272-7737).)

When there is pollution of aquatic ecosystems, much of it settles into the submersed sediments. Therefore, research and regulatory effort is being spent on assessing sediment toxicity. This textbook presents much information on sediments and toxicity assessment.

It includes chapters on assessing quality; sediment variability; sediment collection and processing; assessment using estuarine, marine and freshwater community structures; testing using aquatic biota; predicting and testing bioaccumulation; and a discussion of the US EPA sediment management strategy. The book also includes case studies of contaminated sediments in Puget Sound (Washington) and the Elizabeth River (Virginia).

USER'S MANUAL FOR INSECT (VERSION 1.0); A SIMULATION OF WATERHYACINTH PLANT GROWTH AND NEOCHETINA WEEVIL DEVELOPMENT AND INTERACTION (Includes Insect Program on Disk), by R.M. Stewart and W.A. Boyd, U.S. Army Corps of Engineers, Vicksburg, Mississippi, 1992, 51 pages.
(Order from National Technical Information Service, 5285 Port Royal Road, Springfield, VA 22161. Instruction Report A-92-1, December 1992.)

The **INSECT** (v. 1.0) program was developed to help evaluate how environmental conditions affect the growth and development of water hyacinths and water hyacinth weevils (*Neochetina* spp.) in a biological control system. The user selects and inputs variables including weather, initial plant biomass, insect life stage and time. Simulation results are output in the form of graphs. The program runs on MS-DOS computers with math coprocessors and 260 KB of RAM.



Myriophyllum heterophyllum

Free Drawings Available

Large-format drawings of more than 60 aquatic plants are available free of charge from **APIRS** to anyone who needs them. See Page 3 for more information.

MEETINGS

20TH ANNUAL CONFERENCE ON WETLANDS RESTORATION AND CREATION. May 13-14, 1993, Sheraton Grand Hotel, Tampa, Florida.

This is a forum for the exchange of research results in the restoration, creation, and management of freshwater and coastal wetlands systems. For information, contact F.J. Webb, Hillsborough Community College, Plant City Campus, 1206 N. Park Road, Plant City, FL 33566, 813-757-2104.

JOINT MEETING - SOCIETY OF WETLAND SCIENTISTS 14TH ANNUAL MEETING, AND THE AMERICAN SOCIETY OF LIMNOLOGY AND OCEANOGRAPHY. May 30-June 3, 1993, University of Alberta, Edmonton, Alberta, CANADA.

The theme for this joint meeting is: *Freshwater, Marine and Wetland Interfaces: Dynamics and Management*. Field trips to peatlands, wetlands, and fresh and saline lakes will be featured. For information, contact Lyndon Lee, L.C. Lee & Associates, Inc., 221 1st Avenue West, Suite 415, Seattle, WA 98119, 206-283-0673.

2ND SYMPOSIUM ON THE SOCIAL AND ECONOMIC DEVELOPMENT OF WETLANDS. Fall 1994, Science Academy of Cuba, Matanzas, CUBA.

The purpose of the meeting is to bring together biologists, geologists, ecologists and engineers to discuss ways to "save wetlands for the future."

OXYGEN AND ENVIRONMENTAL STRESS IN PLANTS, 1st International Conference. September 6-10, 1993, University of St. Andrews, SCOTLAND.

The sessions of this conference will cover the effects of ozone and atmospheric chemistry on plants, free radicals in plants, plant survival in anoxic environments, and effects of ionizing radiation.

For more information, contact Dr. B.A. Goodman, Scottish Crop Research Institute, Invergowrie, Dundee DD2 5DA, Scotland, UK.

EWRS 9TH INTERNATIONAL SYMPOSIUM ON AQUATIC WEEDS. 12-16 September 1994, Trinity College, Dublin, IRELAND.

The European Weed Research Society organizes the aquatic weed symposium every four years. As have the previous eight, the upcoming symposium relates to the biology, ecology, spread and control of aquatic weeds in temperate and tropical climates.

Of particular concern this time are the effects aquatic weeds have on the functioning of aquatic ecosystems, natural biological community processes and man's use of water. Scientists, engineers, managers, conservationists and environmentalists will all find a forum where they can meet in comfortable surroundings and exchange ideas.

For more information, contact Dr. Joe Caffrey, Central Fisheries Board, Mobhi Road, Glasnevin, Dublin 9, IRELAND.

The Light Pipette

A new device has come on the market for computer-assisted studies of photosynthesis. Designed for both aquatic and terrestrial applications, it is called the "Light Pipette". It is manufactured by ILLUMINOVA AB of Uppsala, Sweden.

According to Dr. Erik Brammer, until now there has been no way to honestly measure quantum yield or light utilization efficiency in photosynthetic research, and no way to replicate exact light conditions from one experiment to the next. He points out that this is especially peculiar since it has long been taken for granted that length, mass, time and temperature are measured in micrometers, micrograms, milliseconds and centidegrees. Brammer states that "it is high time not only to correctly measure but also to accurately simulate and manipulate selected light fluxes" in photosynthetic and other plant physiology research.

The Light Pipette has a patented optical assembly (a "light homogenizer") that is able to simulate the spectral and quantitative requirements of photosynthetically active radiation (PAR) of sunlight. The Light Pipette may be set to photon flux densities between 0 and 3000 micromoles of quanta per meter square and second. This makes it possible to simulate any sequence of "natural" light needed for photosynthetic research. The device also has slots for standard filters and space for light shutter mechanisms.

On-line computer monitoring and control of the Light Pipette is achieved through the computer program, CAMP (Computer-Assisted Monitoring of Photosynthesis). This IBM-compatible program also stores data files for graphic analysis and/or printout.

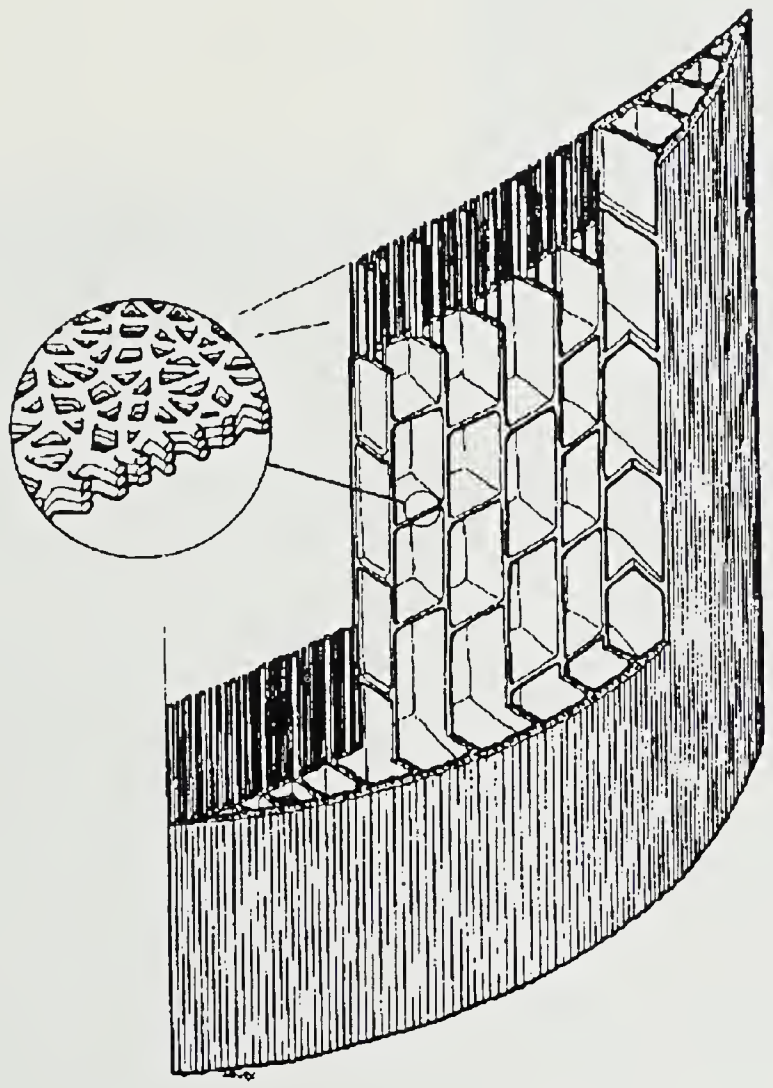
For more information about this new device, contact Erik Brammer, Ph.D., Managing Director, ILLUMINOVA AB, Box 23051, S-750 23 Uppsala, SWEDEN.

Examining A Natural Invention

Nature provides many models for man's technological developments--the sonar of bats, the skin of dolphins, the hair of goats. Here is another one--the structure of the cattail leaf.

Considering that a cattail leaf is only an inch or two wide and up to eight or nine feet long, how is it able to stand upright? And how is it that it still stands even after terrific wind storms? The answers are in its structure.

In a recent issue of the *Botanical Journal of the Linnean Society*, Ursula Rowlatt (Kew Botanical Gardens) and Henry Morshead (Department of Aeronautics, Imperial College of Science) closely examined the structure of the cattail leaf (*Typha latifolia*). As the researchers point out, the cattail leaf is built remarkably like airplane wings and helicopter blades. Or rather the other way round.



The leaf is flat on the inner surface and rounded on the outer surface through most of its length. Inside, the leaf is made of multiple columns of rectangular compartments, giving the leaf a "closed-box rigidity".

It is strengthened width-wise by thin diaphragms of various thicknesses, that separate the rectangular compartments. As an engineer might do, the diaphragm thicknesses are ordered in a strict sequence of eight which imparts maximum strength. The 1st,3rd,5th and 7th diaphragms are thin; the 2nd, 4th, and 6th diaphragms are thicker; and the 8th diaphragm is always the thickest.

The leaf is strengthened and held length-wise by numerous parallel fibrous strands. These tiny cables give the cattail leaf its finely ribbed exterior surface.

Another important structural characteristic of the cattail leaf is its twist. Along its length, the cattail leaf twists clockwise and upward one and one-quarter to one and one-half turns (450° to 540°). The researchers conclude that the twist is why the cattail leaf can withstand strong winds: the twist greatly minimizes the lift and drag from the wind. As a result, the net sideways force from the wind is close to *zero.*

The researchers also describe how the "soft mounting" of the cattail plant, (its tangled rhizomes), absorbs much of the wind energy it receives.

An airplane wing cross section

Rowlatt and Morshead interpret these findings in terms of advanced construction: "it may be regarded as a light weight cantilever beam mounted vertically...Such a sandwich-type construction is frequently used in the aerospace industry where high stiffness and low weight are required." Such places include airplane wings and helicopter rotor blades.

If you wish to know more about the details of the cattail leaf structure, and how each structural component shares the weight and other force loads, and an analysis of its "bending moment", "static, dynamic and compression loads", and "shear webs", see "Architecture of the leaf of the greater reed mace, *Typha latifolia* L.", *Bot. J. Linnean Soc.* 110:161-170, 1992.

Institute of Food and Agricultural Sciences
AQUATIC PLANT INFORMATION
RETRIEVAL SYSTEM (APIRS)
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University of Florida
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(904) 392-1799

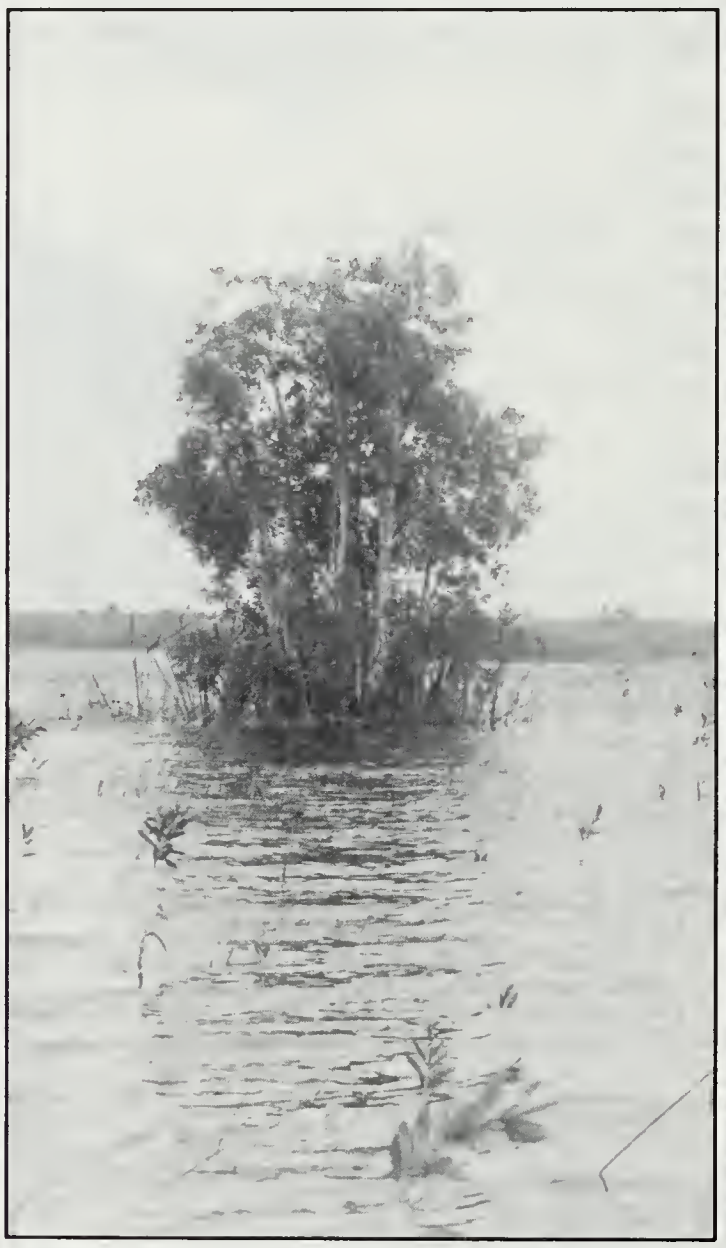
AQUAPHYTE

This is the newsletter of the Center for Aquatic Plants and the Aquatic Plant Information Retrieval System (**APIRS**) of the University of Florida Institute of Food and Agricultural Sciences (IFAS). Support for the information system is provided by the Florida Department of Natural Resources, the U.S. Army Corps of Engineers Waterways Experiment Station Aquatic Plant Control Research Program (APCRP), the St. Johns River Water Management District, and IFAS.

EDITORS: Victor Ramey
Karen Brown

AQUAPHYTE is sent to 4,500 managers, researchers and agencies in 87 countries. Comments, announcements, news items and other information relevant to aquatic plant research are solicited.

Inclusion in *AQUAPHYTE* does not constitute endorsement, nor does exclusion represent criticism, of any item, organization, individual, or institution by the University of Florida.



Lake Melaleuca (aka Lake Okeechobee)

At left above is a healthy stand of exotic melaleuca trees (*Melaleuca quinquenervia*) growing in the waters of Lake Okeechobee, Florida. Fast-growing saplings surround the larger trees. At right, Ms. Jackie Jordan (Florida DNR) stands knee-deep in water at the base of a larger clump of melaleuca trees in the lake. (See story on page 2.)

A Q U A P H Y T E

UNIVERSITY OF FLORIDA
Institute of Food and Agricultural Sciences

CENTER FOR AQUATIC PLANTS

With Support From
The Florida Department of Environmental Protection,
Bureau of Aquatic Plant Management
The U.S. Army Corps of Engineers, Waterways Experiment Station,
Aquatic Plant Control Research Program

Volume 13 Number 2 Fall 1993 GAINESVILLE, FLORIDA ISSN 0893-7702

VETIVER GRASS - AN EXOTIC, BUT . . .

Deliberately spreading an exotic plant around the world sends chills down the spines of many people, especially those charged with controlling exotic weeds. Many exotic weed problems come readily to mind - hydrilla, water hyacinths, water milfoil, melaleuca, Australian pine, giant salvinia, torpedo grass, and others, depending on which part of the world you live in. In Florida alone, millions of dollars are allocated each year for the control of introduced exotic species. So why is the World Bank and the U.S. National Research Council (NRC) touting the use of an exotic species of grass, native to India, that grows two to three meters high with roots up to three meters deep?

Vetiver grass (*Vetiveria zizanioides*) is a coarse perennial "stiff-stem" grass found in the tropics of the Old World. It is in the same family as maize, sorghum, sugarcane and lemongrass. Named in 1771 by Linnaeus, *zizanioides* means "by the riverside", reflecting that it is commonly found along waterways in India. It is described as both a xerophyte and a hydrophyte (World Bank, 1990), or semiaquatic (Cook, 1990). Another species native to Africa, *V. nigritana,* is aquatic.

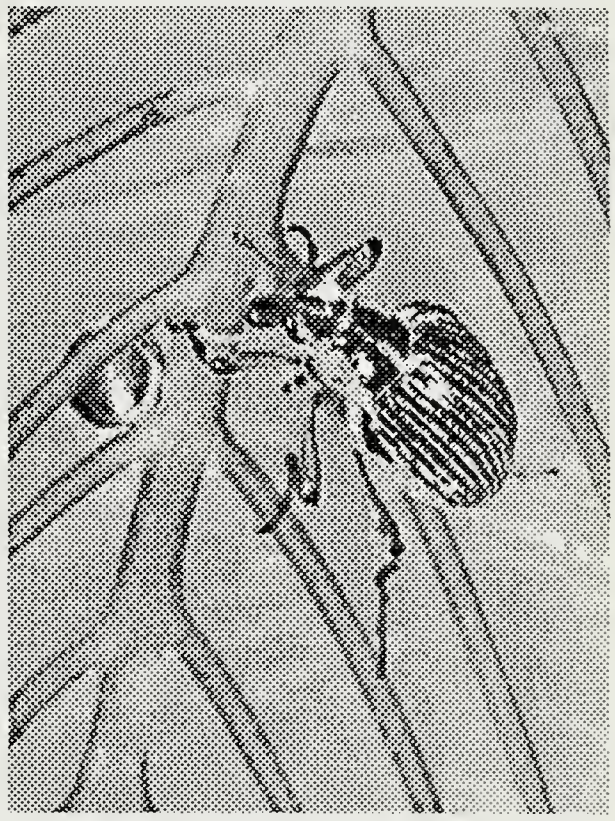
Vetiver tolerates an exceptionally wide pH range, and grows in any type of soil regardless of fertility. Its long, fibrous roots form a dense underground curtain. The grass is disease resistant, fire resistant, salt tolerant, and contains a strong aromatic oil that makes it unpalatable to rodents. It can withstand trampling and grazing by large animals because the plant crown remains below the surface of the soil. It also can withstand drought. The NRC states that "Vetiver is at home on the interface between land and water. It is one of the few terrestrial plants able to take wet conditions, even total immersion. For this reason alone, it might become outstandingly useful." (1993) In an aquatic situation, might it become an outstanding nuisance?

ADVANTAGES

The features that make vetiver grass sound potentially formidable also make it sound like a rather remarkable plant for erosion control and water retention. Agricultural agents in developing countries recommend vetiver grass as a contour hedge for farming on sloping land. When planted as a tight hedge along the contour of the land, vetiver significantly slows water run-off from fields which allows time for water to soak into the soil before continuing along the normal watershed. The run-off also is filtered by the grass so that soil and organic debris collect at the hedge. This process causes a large, earthen terrace gradually to build up in front of the hedge, further stabilizing the sloping land and providing more land for farming. The extensive roots of vetiver grass are fibrous and grow straight down as opposed to spreading outward, which would interfere with crop growth. The deep roots anchor the plant firmly in the ground and stabilize soil even on steep slopes with large amounts of water run-off.

Vetiver grass also appears to be effective for stabilizing gullies when planted as a barrier across them. When used as a border grass, its dense growth is reported to prevent the rhizomes of weedy grasses from invading crops. In Ethiopia, the local

[See Vetiver on Page 8]



NATIVE WEEVIL EATS EXOTIC WEED

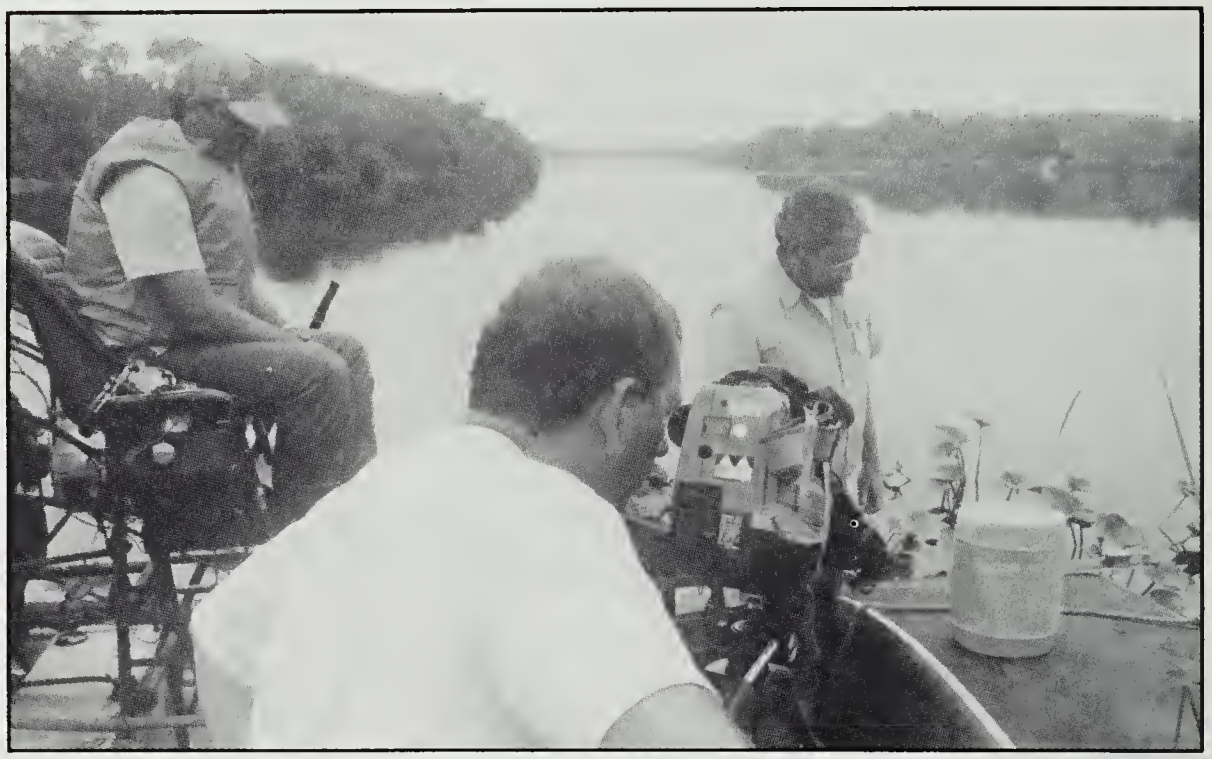
Interest is being shown lately in the North American weevil, *Eurhychiopsis lecontei*, as a biological control agent for the exotic submersed plant Eurasian watermilfoil (*Myriophyllum spicatum* L.). The weevil has been associated with declining populations of watermilfoil in the northeastern United States.

Robert Creed and Sallie Sheldon (Department of Biology, Middlebury College, Vermont) have studied *E. lecontei* in Brownington Pond in Vermont since 1990, and have surveyed many other New England lakes for *Eurhychiopsis* and other herbivorous insects. Their work shows that all life

[See WEEVIL on Page 7]

Videophile

Here are three more APIRS-produced videotape programs for your viewing pleasure...



Aquatic Pest Control Applicator Training, Part I and Part II

Part I, 28 min., IFAS Catalog No. VT-1068;
Part II, 30 min., IFAS Catalog No. VT-1069.

These programs teach the basic knowledge necessary to become "certified" as a restricted use pesticide applicator in aquatic pest control (category 6) in Florida. Topics include a brief history of aquatic plant management, laws, herbicide technology, biological control, mechanical control and environmental effects. The programs were adapted from the *Aquatic Pest Control Applicator Training Manual* (IFAS Publ. SM-3), edited by Dr. Ken Langeland.

NHRA Gainesville Raceway Wastewater Treatment System

15 min., IFAS Catalog No. VT-455

In this program, Dr. Jerome Shireman (UF Department of Fisheries and Aquatic Sciences) explains the design and functioning of an innovative sewage treatment system, which processes the waste of 100,000 spectators at the annual Gatornationals auto racing event. This "batch" system uses aquatic plants as part of the treatment process, features on-site water disposal, produces fish and pine trees as salable end-products, and occupies only five acres of land.

Hormone Induced Spawning Of Grass Carp

25 min., IFAS Catalog No. VT-038

Grass carp are an effective biological control of submersed aquatic weeds, as well as a food-fish in many countries. Written by Mr Roger Rottman (UF Department of Fisheries and Aquatic Sciences), this video covers brood fish, mixing hormones, injecting fish, taking the spawn, inducing triploidy (by pressure), incubating eggs, stocking the fry, and raising them to salable fingerlings.

Programs **may be borrowed** from the Information Office (904/392-1799). Or they **may be purchased** from IFAS Publications, IFAS Building 664, Gainesville, FL 32611-0001 (904/392-1764). Each videotape costs US$15.00 (plus .90 tax for Florida residents), payable to the University of Florida. Checks or purchase orders are accepted. Specify VHS or European PAL format.

A T T H E C E N T E R

GRASS CARP SYMPOSIUM

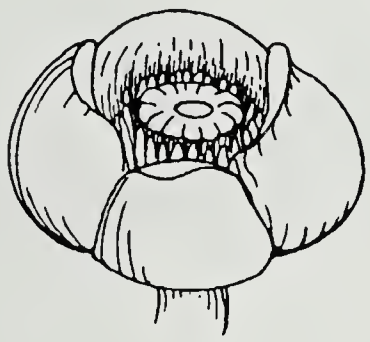
During a symposium to be held March 7-9, 1994, researchers and managers from across the U.S. will assess the environmental impacts of using grass carp in large lakes and reservoirs in the southern United States. The meeting will convene at the University of Florida Reitz Union.

It is co-sponsored by the Center for Aquatic Plants, the Florida Department of Environmental Protection, the Florida Game and Fresh Water Fish Commission, the U.S. Army Corps of Engineers - WES, the Tennessee Valley Authority, and B.A.S.S., Inc. For information, contact Bobbi Goodwin at 904-392-9613.

NUPHAR STUDY BEGINS

Dr. Ken Langeland, together with recent weed science graduate Mr. Brian Smith, will be conducting studies on spatterdock (*Nuphar luteum*) seed germination and ecological factors affecting seedling survival. Dr. Michael Kane of the Environmental Horticulture Department also will be working on the project to develop micropropagation techniques for *Nuphar*.

Spatterdock and other native plant populations have significantly declined in Lake Griffin, Florida. The researchers hope to apply their findings to restoration efforts in the lake during a pending drawdown. The restoration work will be coordinated with the Florida Game and Fresh Water Fish Commission.

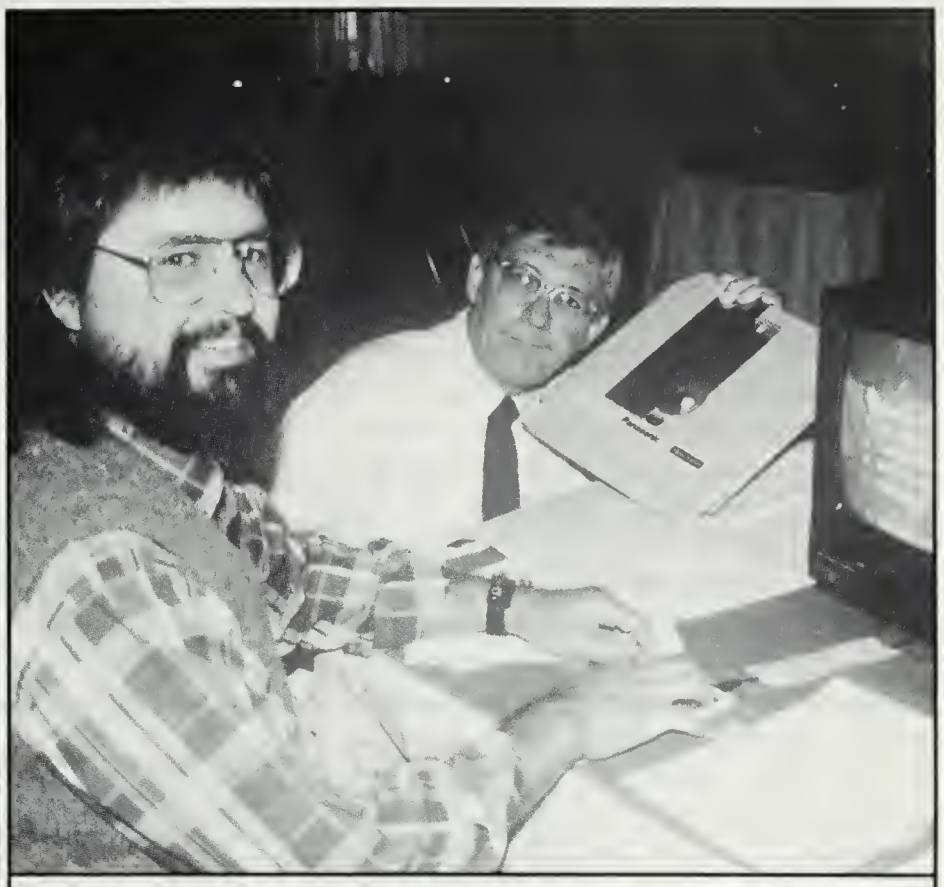


AQUATIC PLANT HERBARIUM

'Til now at the University of Florida, most aquatic plant identification services and all aquatic plant archiving have been done by the university's herbarium. The Center for Aquatic Plants has long needed its own herbarium.

Now, room has been constructed and herbarium cabinets have been purchased for the start of an aquatic plant collection to be housed at the Center. Dr. Ken Langeland intends to make use of the many samples that Florida **LAKEWATCH** volunteers and others frequently bring to him for plant identification. With the help of the Herbarium, Langeland will preserve and catalog the specimens into a herbarium collection which will be open to the public.

Although the collection will concentrate on Florida species, Langeland wants to include specimens of exotic species with weed potential for Florida such as *Lagarosiphon, Nechamandra,* and others. He hopes to acquire these specimens through exchange with other herbaria.



HAVE DISC, WILL TRAVEL

The use of "interactive videodiscs" in training and education has increased in recent years. Inexpensive off-the-shelf videodisc players and TV sets are all that are required to take advantage of this technology, which provides random access video and instructional segments, guided by the user by on-screen menus. Many of you have used them in the form of "information kiosks" in shopping centers, airports and museums. Many of your children use them in school to learn about everything from biology to art.

Recently, a prototype interactive videodisc on the identification and control of submersed aquatic plants was demonstrated at the annual meeting of the U.S. Army Corps Aquatic Plant Control Research Program (APCRP) in Baltimore. The videodisc is under development by the University of Florida Center for Aquatic Plants and the APCRP. The goal is to develop better training materials for Corps water managers throughout the country.

Above, disc developer Vic Ramey demonstrates the prototype to Greg Jubinsky, of Florida's Department of Environmental Protection. Ramey holds a copy of the prototype in the form of a rewritable optical disc.

CENTER FOR AQUATIC PLANTS
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Dr. William Haller, Interim Director

Hydrocotyle ranunculoides in the Canning River

by R. Ruiz-Avila, V. Klemm and N. Siemon, Environmental Investigations and Assessments Division, Swan River Trust, Perth, Western Australia

The Swan-Canning River is a major river system flowing through Perth, the capital of Western Australia. In the early 1980s the aquatic weed *Hydrocotyle ranunculoides* was observed in a creek and within five years it had spread into the Canning River Regional Park. *Hydrocotyle ranunculoides,* a common aquarium plant, was readily available throughout Western Australia. In the Canning River it probably originated from the release of garden and aquaria wastes into drains. The weed remained fairly static in the river system until early 1991, when the distribution suddenly became more extensive. It is now a major problem which must be controlled in the short-term and eradicated in the long-term.

In the Canning River *Hydrocotyle ranunculoides* is a floating, stoloniferous plant with a creeping stem. Profuse filiform roots grow down from the stem into the water and the leaves emerge above. The plant anchors to the bank and grows vegetatively, forming large dense mats up to several hundred meters long and one meter deep. When broken off from a mat, a small piece of stem can grow into a new mat, making any eradication attempts difficult.

By September 1992, the estimated volume within the Canning River Regional Park had increased to 420 tonnes along approximately six kilometers of the river. The infestation of *Hydrocotyle* in the Regional Park is a serious problem as the mats affect the ecological and recreational values of the River. There was widespread concern that *Hydrocotyle* may be transported to irrigation channels and other naturally occurring fresh water bodies in the State. This could result not only in environmental degradation but also economic loss including reduced access to water for crop irrigation.

In 1992 *Hydrocotyle ranunculoides* was "declared" by the Agriculture Protection Board, requiring control and eradication of the plant. In association with other state government agencies, local government and community representatives, the Swan River Trust has designed a two part control and eradication strategy. Both strategies are based on the concept of integrated control using a combination of mechanical, chemical, biological and ecological control techniques where appropriate. This approach reduces the potential environmental impacts of any one control technique.

Canning River in 1992 *before* being completely choked by *Hydrocotyle*.

Short-term control program

The aim of the short-term control strategy was to remove the majority of *Hydrocotyle* from the Canning River Regional Park and its associated drains during the summer of 1992/1993. This strategy relied largely on physical techniques (removal) with selective use of chemicals. Biological and ecological control techniques were either unsuitable or unavailable for use in the short-term but will be used where possible in the long-term.

The program operated by removing the weed from a section of the river and then moving the operations downstream for the next stage. Physical removal involved the cutting of floating mats of *Hydrocotyle* with sickles and scythes from small boats. The mats were pushed by small boats to the weed harvester which then floated them to the bank where they were removed by backhoe. Approximately 2,000 tonnes were removed using these methods. The weed was then used for composting.

[See ***Hydrocotyle*** on page 5]

[Hydrocotyle, From Page 4]

After most of the weed had been removed, chemical control techniques were used along the banks to prevent new mats growing out. The rhizomes of *Hydrocotyle* can grow to 15 cm below the soil on the bank and a translocative herbicide is required for these to be destroyed. Glyphosate was selected on the basis of glass-house experiments and its low toxicity to mammals, fish and microbes and its low to medium toxicity to birds and other aquatic life. Preliminary assessments of the chemical control program have indicated that treatment was successful.

Long-term eradication program

The aim in the long-term is to eradicate this weed from the river system, thereby preventing its spread through the state. A combination of techniques will be used in the long-term strategy. These include biological, ecological, physical and chemical methods.

At this stage a biological control for *Hydrocotyle* is not available and may take up to ten years to develop. It is unlikely that a suitable biological control agent will be developed and approved for release in the near future. Ecological techniques which may be used include the reduction of nutrient loads to the river and removal of nutrient rich sediments. The reduction of nutrients to the Canning River would reduce the opportunities for invasion of other aquatic weed species.

Chemical control will be used on an on-going basis to prevent regrowth of any small fragments. The use of physical removal by boats and backhoes will be necessary if mats generate.

A surveillance program has been initiated to ensure early detection and control of any outbreaks. On-going monitoring of aquatic invertebrates and pesticide levels is being undertaken as part of both the short and long-term programs to assess the environmental impacts.

Based on strategies used to control other aquatic weed species in Australia, eradication may be an optimistic goal. In three to five years plant numbers will probably be reduced to levels that allow regular but low levels of control activity. If this is the case, control and management, rather than eradication, will be the most feasible option.

For those interested in more details, write for a free copy: *Hydrocotyle ranunculoides*: A control strategy for the Canning River Regional Park, Report No. 6, Swan River Trust, by V.V. Klemm, N.L. Siemon and R.J. Ruiz-Avila, 1993, 62 pp. Order from R. Davies, Chairman, Swan River Trust, 16th Floor, London House, 216 St. George's Terrace, Perth, Western Australia, 6000, AUSTRALIA.

MEETINGS

FIFTH ANNUAL FLORIDA LAKES MANAGEMENT CONFERENCE. April 27-29, 1994, Ramada Hotel Resort, Orlando, Florida.

The conference theme is "Lake Ecology and Management". It is co-sponsored by the Florida Lake Management Society (FLMS) and the Lakes Education/Action Drive (LEAD). For information, contact G. Medley, City of Lakeland Lakes Program, 407 Fairway Avenue, Lakeland, FL 33801, 813-499-8272.

21st ANNUAL CONFERENCE ON WETLANDS RESTORATION AND CREATION. May 19-20, 1994, Sheraton Grand Hotel, Tampa, Florida.

This annual conference provides a forum for nationwide exchange of results of scientific research in the restoration, creation and management of freshwater and coastal wetland systems. For information, contact F.J. Webb, Hillsbororugh Community College, Plant City Campus, 1206 N. Park Road, Plant City, FL 33566, 813-757-2104.

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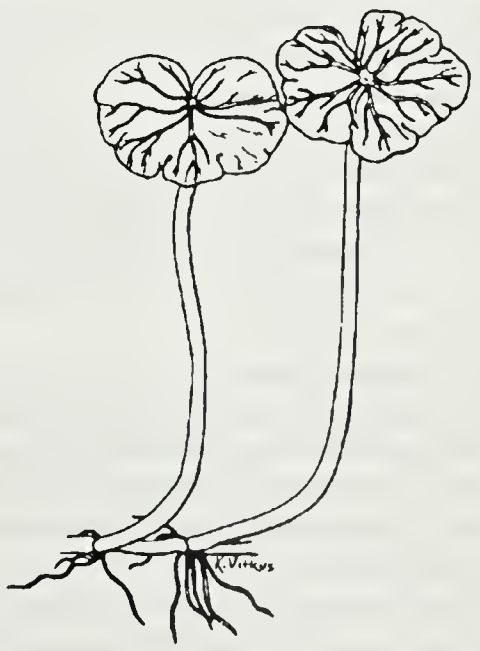
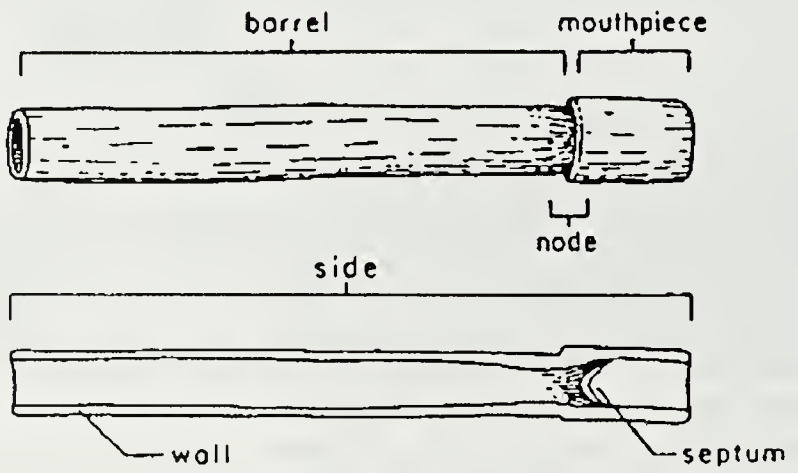


600-year-old cigarettes



At the Red Bow Cliff Dwelling in Arizona, hundreds of prehistoric cigarettes have been found, some wrapped in cotton, some tied together, and others adorned with miniature bows.

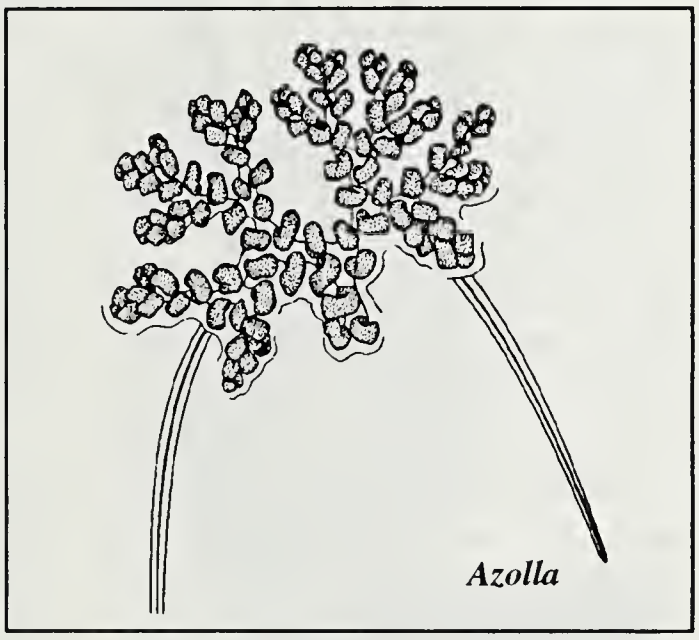
K.R. Adams of the Crow Canyon Archaeological Center in Cortez, Colorado, sampled a dozen of the cigarettes and con-firmed previous sug-gestions: the 600-year-old smokes are made from the stems of the giant reed (*Phragmites australis*), and contain tobacco (*Nicotiana* spp.). The reed "barrel" of the cigarette was stuffed with tobacco. The tobacco was lit and smoked; the tough reed exterior did not burn, and was used again.

In her review of other research, the author found that other "historic North American groups" (Hopi, Comanche, etc.) smoked parts of at least 13 kinds of plants, and at least one kind of bird feathers.

For more information about the use of giant reed cigarettes by native Americans, see "Prehistoric reedgrass (*Phragmites*) "cigarettes" with tobacco (*Nicotiana*) contents: a case study from Red Bow Cliff Dwelling, Arizona", by K.R. Adams, *J. Ethnobiology* 10(2):123-139, 1990.

The **APIRS** database includes more than 1,000 articles about the use of aquatic plants for food, medicine, construction, weaving, etc. A sampling from the database using the term "ethno" ("used by or related to a people or race") retrieves about 25 citations.

Biofertilizer technology for dry season rice



Millions of tons of topsoil and nutrients are displaced by erosion every year. Much of it runs off into ponds, lakes and rivers. Billions of dollars in commercial fertilizer are needed by farmers to replace the lost nutrients. If only farmers could reclaim the nutrients from the water and replace them on their crops...

The small floating ferns of the genus, *Azolla*, scavenge nutrients from polluted waters and, in symbiosis with the bacteria, *Anabaena*, "fix" nitrogen. Because it is so rich in nutrients, *Azolla* is used as "biofertilizer" by rice farmers in China, Vietnam, Thailand, India and elsewhere.

In India, a major problem is not having enough *Azolla* biomass growing near rice fields at the time biofertilizer is needed most, especially during dry season rice culture. Dry season rice culture in India usually begins around March.

Therefore, Indian researchers are looking for ways to keep large quantities of *Azolla* under cultivation during the cold months prior to March. Investigators are studying the effects of different tree canopies, in terms of how well trees protect *Azolla* from lethal cold temperatures, and how tree leaf leachates affect *Azolla* growth. (The fallen dead leaves of some trees kill *Azolla* while the leaves of other trees "remarkably increase" its biomass production and nitrogen content.)

Other investigators are studying the production of spores. The use of spores could have advantages over the use of grown plants: spores can easily over-winter, and can be easily transported, and would not require the use of additional water bodies for grow-out purposes. Spore collection, storage, packing and distribution could become village industries.

Above, Dr. D.P. Kushari and his colleagues at the University of Burdwan are working to overcome the problems of using *Azolla* as a biofertilizer for dry season rice in India. Contact them at the University of Burdwan, Department of Botany, Golapbag, Burdwan-713 104, West Bengal, INDIA.

[Weevil, From Page 1]

stages of the weevil are associated with Eurasian watermilfoil. Adults lay their eggs on the meristems; larvae burrow into and feed on the meristem before moving down and into the stem. Pupation occurs inside the stem. Adults feed on the stems, leaves and leaflets of watermilfoil, and mate on the plant. They appear to concentrate feeding on the upper portions of the plant, removing significant amounts of photosynthetic tissue. Also, stem damage from both adults and larvae causes watermilfoil to lose its buoyancy and sink. The researchers suggest that the loss of buoyancy may be more significant in controlling the plant than the loss of leaves.

The weevils appear to prefer the exotic *M. spicatum* over the native milfoil *M. sibiricum* Komarov (= *M. exalbescens* Fernald). Creed and Sheldon suggest that the weevil may have either expanded its diet to include *M. spicatum* or undergone a host shift from the native plant to the exotic one.

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[Vetiver, From Page 1]

name for vetiver grass reportedly translates to "stops couch grass", a troublesome creeping grass weed in cultivated fields. Some Indian farmers even claim that its downwardly sharp, stiff leaves keep snakes away.

Other advantages of vetiver grass are that it is easy to propagate, inexpensive to plant, simple to maintain, and long lasting. In fact, agricultural agents report that one of the difficulties in promoting its use is that local people often mistrust such a simple solution to their massive erosion problems. They feel that something requiring heavy equipment, engineers, a lot of money and a lot of labor must be required.

EROSION CONTROL

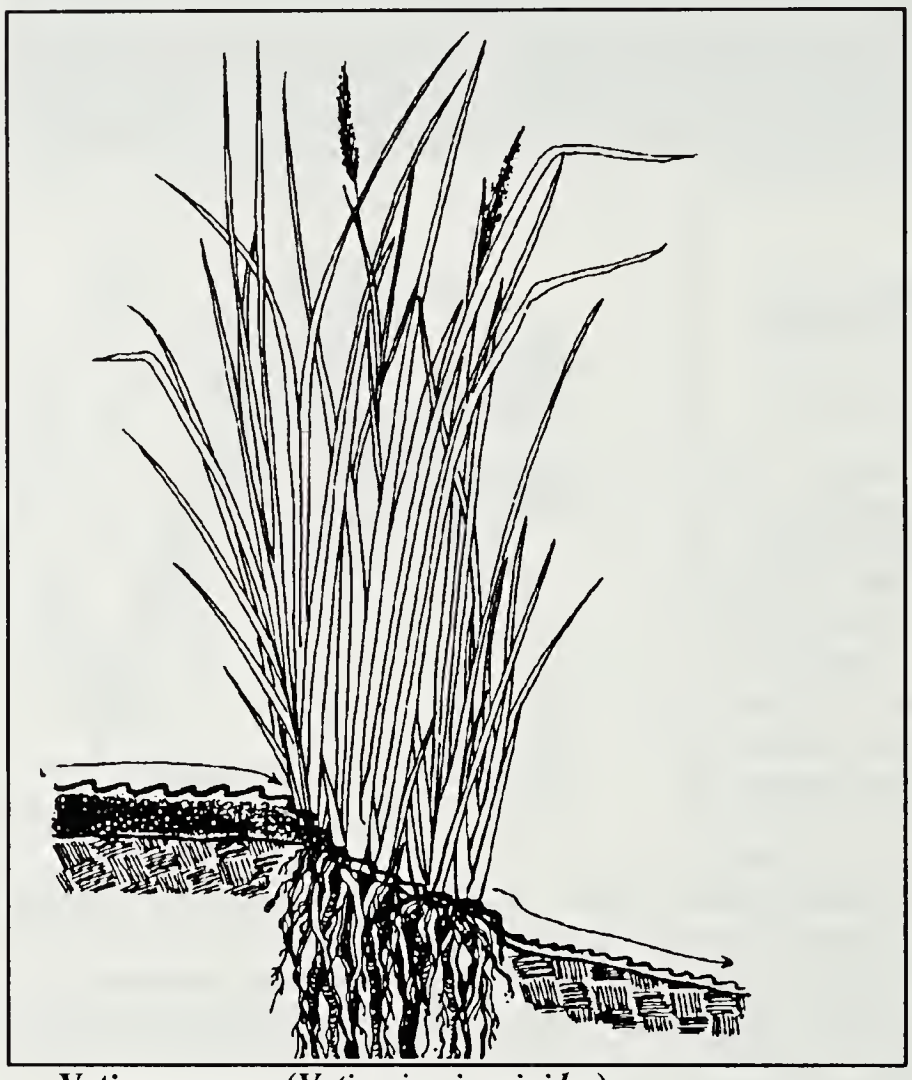
The World Bank has been promoting the study and use of vetiver grass in developing countries with severe soil erosion problems. In many developing nations, torrential downpours, winds or flash floods can wash away tons of precious topsoil which end up in equally precious waterbodies. The National Research Council reports that erosion costs the earth 20 billion tons of soil a year worldwide. This equals the loss of between 5 million and 7 million hectares of arable land. In *Vetiver Grass - A Thin Green Line Against Erosion,* soil erosion is dubbed a "double disaster: a vital resource disappears from where it is desperately needed only to be dumped where it is equally unwanted."

OVERSEAS

Farmers near Mysore, India have been using vetiver hedges for perhaps 200 years and sugar companies in the West Indies and Fiji have used vetiver for more than 50 years to turn steep mountain slopes into profitable farmland. The grass is used to prevent erosion in tea and rubber plantations in Malaysian mountains where farmers cut flat areas, or benches, into the sides of mountains. Vetiver is found in more than 20 countries in Africa, a dozen Caribbean islands, throughout Asia (its native range), South America, the Pacific Islands, and elsewhere. In India, it has long been used around rice paddies, and along rivers, canals and ponds to strengthen banks.

More recently, vetiver has been used as a contour hedge on hill slopes to conserve water and soil on farms. Studies on this method of soil and water conservation have been carried out largely with funding from the World Bank. Vetiver is being studied by the International Rice Research Institute in the Philippines for erosion control and to reinforce bunds around paddies. Large projects are being carried out in China for soil and water conservation, to protect existing terraces and restore gullied lands. Great Britain's Prince Charles personally planted vetiver in Anambra State in Nigeria to promote its use to local farmers. In Trinidad, mango trees close to vetiver hedges reportedly flourish compared to trees farther away, most likely from extra moisture and fertility provided by organic matter trapped by the hedges.

There are many other records of vetiver grass being used to establish boundaries, to protect agricultural terraces, to stabilize riverbanks, canal walls, paddy fields and roadsides, to protect small dams from siltation and dam walls from rill erosion. Vetiver grass can be used as livestock bedding, compost, windbreaks, firebreaks, roof thatch, mulch, and basket and broom material. Its oil is used for perfumes and soaps. In several Indian villages, it is even credited with raising water levels in wells due to its ability to hold run-off so that water can soak into the ground.



Vetiver grass (*Vetiveria zizanioides*)

UNITED STATES

Vetiver grass has existed in the United States for at least 150 years. A family in Louisiana has been farming it for three generations for its aromatic oil which is used to make sachets. It is found along the banks of bayous and on old plantations. Vetiver is currently being used in agricultural areas in northern Louisiana as a substitute for earthern terraces.

In 1990, vetiver was field tested in an attempt to correct severe erosion problems plaguing Fort Polk in Leesville, Louisiana. Fort Polk is home to the Fifth Mechanized Infantry where soldiers are taught to drive tanks on steep (18-30%) slopes. Unfortunately, the fort also is home to the headwaters of three scenic streams that were rapidly filling with silt as tanks on training maneuvers scoured the land. After sediment-filled waters sluiced over check dams built by the Army, Mike Materne of the U.S. Soil Conservation Service (SCS) in Louisiana was called in.

Materne planted vetiver grass both in waterlogged soil below sediment basins and in dry sand above sediment basins to test its effectiveness in slowing water flow and filtering suspended materials. The grass was also planted on side slopes in highly eroded areas. The plants thrived and quickly grew together into hedges. Materne reports that the hedges captured 50 centimeters of soil in two

years and succeeded in reducing and cleansing the turbid run-off to acceptable levels. He calls the success "phenomenal".

In Florida, vetiver is being investigated by the SCS for use in biological filter strips for wastewater run-off from livestock production in confined pastures and for nutrient run-off from row crops and groves; as a cover crop to protect soil surface and reduce runoff; and for cropland gully stabilization.

When questioned about the plant's weed potential, plant materials specialists at the SCS claim that vetiver grass in the U.S. does not produce viable seed. Materne has made repeated attempts to germinate the seeds without success. It is reported that the plant can be easily killed by slicing off the crown which grows just below the soil surface. Vetiver also succumbs to glyphosate herbicide and is not very cold tolerant. (Incidentally, it is reported in Malaysia that Chinese grass carp readily eat the leaves of vetiver grass.)

The U.S. Army also is interested in vetiver grass. The Construction Engineering Research Lab (CERL) in Champaign, Illinois will be supervising research to establish the geographic range of vetiver grass. Plant material currently is being grown at army installations in the southeast. The plant also will be studied for its efficacy as a sediment filter around disturbed wetlands, for streambank stabilization, and for controlling erosion on slopes. Dr. Mohammad Sharif reports that vetiver will be studied to see if it can withstand vehicular traffic. Researchers plan to drive 60-70 ton tanks over the grass.

The NRC makes the sweeping statement that "Countries benefit by having cleaner rivers, unspoiled estuaries, and more water and less silt in their reservoirs." Certain caveats, however, arouse a certain amount of unease in those struggling with exotic weed problems: the NRC recommends that those looking for vetiver grass look in their own regions rather than importing seed because "... seed will likely lead to seedy plants, and that in turn could produce badly behaved vetivers that do not stay where they are put." They state that the purpose of their most recent book on the plant (see below) is "to assess vetiver's promise and limitations and to identify any research that may be necessary before this grass can be deployed rationally, widely, and without undue environmental risk."

Here in the United States, using native species is a very popular tenet, almost dogma, with environmental purists, biologists, restoration researchers, some government agencies and others. However, when environmental problems overwhelm our native plant populations, perhaps the carefully controlled use of a non-native species should not be wholly discounted.

K.B.

(*Vetiver Grass: A Thin Green Line Against Erosion* is available from the National Academy of Sciences, 2101 Constitution Avenue N.W., Washington, DC 20418. The cost is $12.00 plus $4.00 shipping and handling.)

Send More Stories

We at **APIRS** enjoy assembling and producing the newsletter *AQUAPHYTE.* (Five thousand researchers, managers and students subscribe to it, about half in the U.S. and half elsewhere.) We know *AQUAPHYTE* is read because of the comments about stories and the requests for more information that its pages elicit.

We have found that readers especially value the contributed notes and reports from researchers and managers around the world.

Therefore, we take this opportunity to ask all of our readers to consider contributing short papers about their work for inclusion in the pages of *AQUAPHYTE.* Our guidelines are:

- the story must have something to do with aquatic plants, and may be about a person, a research project, or a research facility;
- the story should be three to six typed pages;
- the story should include three photographs or slides (preferably black and white), with captions;
- and the story must include the author's name and full address.

The story should be somewhat general in nature so that it can be appreciated by the wide range of people who read *AQUAPHYTE,* and the story should explain in the first couple of paragraphs what the point of the story is. (We do not look for a "news style" or a "scientific article style", but something between the two.)

Your contribution is subject to editing by us.

Send your contribution to the **APIRS** address on the last page. We all look forward to reading it in the pages of *AQUAPHYTE.*

FROM THE DATABASE

Here is a sampling of the research articles, books and reports which have been entered into the aquatic plant database since March, 1993.

The database has almost 36,000 items. To receive free bibliographies on specific plants and/or subjects, contact APIRS at the address shown on the mail label on page 16.

To obtain articles, contact your nearest state or university library.

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BOOKS/REPORTS

LIFE CYCLES OF RICE FIELD WEEDS AND THEIR MANAGEMENT IN MALAYSIA edited by K. Itoh, Tropical Agriculture Research Center, Ministry of Agriculture, Owashi, Japan. 1991. 92 pp. (In English)
(Order from K. Itoh, Department of Lowland Farming, Tohoku National Agricultural Experiment Station, Ministry of Agriculture, Forestry and Fisheries, Omagari, Akita, 014-01 JAPAN.)

According to the *Introduction,* "The most important information for weed management is the in-depth understanding of weeds' life cycle and the strategies adopted to control these species."

This colorful handbook includes 17 species of major weeds in rice fields, especially those in the family Poaceae. Each species is described and its habitat is defined. Effective control methods for each weed are described, including hand pulling and cutting, burning, rotovation, as well as herbicides and biological controls.

What makes this book especially useful and distinctive is its use of many color photographs showing "characteristic parts" of each plant (flowers, seedlings, young plants, comparisons) as well as photographs of each "life cycle". Life cycles are depicted in circles of color photos of each stage of life: seed, emergence, seedling, small plant stages, tillering, growing as weeds, heading, flowering, seed development and dispersal.

A HANDBOOK FOR WEED CONTROL IN RICE by K. Ampong-Nyarko and S.K. De Datta, International Rice Research Institute, Manila. 1991. 113 pp.
(Order from Division PR, Information Center, IRRI, P.O. Box 933, 1099 Manila, Philippines. US$17.50 (including shipping) for developed nations; US$8.25 for developing nations.)

In ten chapters, this book provides practical information on weed management in irrigated rice, rainfed lowland rice, upland rice and deepwater and floating rice. Chapters cover the effects of weeds, identifying 30 weeds and the principles of herbicide use. A special chapter is devoted to especially difficult-to-manage weeds such as *Scirpus maritimus, Cyperus rotundus* and *Rottboellia cochinchinensis.*

RELATIONSHIPS BETWEEN FISH AND AQUATIC PLANTS: A PLAN OF STUDY, Miscellaneous Paper A-93-1, by K.J. Killgore, E.D. Dibble and J.J. Hoover, US Army Corps of Engineers, Environmental Laboratory, Vicksburg, Mississippi. 1993. 64 pp.
(Order from USAE Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg MS 39180-6199. Miscellaneous Paper A-93-1.)

This report includes a comprehensive review of the literature having to do with aquatic plant effects on fish behaviour and population dynamics.

It is the Final Report for a Plan of Study (POS). Based on an evaluation of existing relevant studies, the POS "will be used to document the need for future research, to serve as a basis for prioritizing and designing studies...and to provide documentation for developing a new technology area in the Aquatic Plant Control Research Program."

Based on their literature review, the researchers concluded that more research emphasis needs to be placed 1) on the early life stages of fish; 2) on predator-prey relationships; 3) on behavioral studies and new ways of sampling; 4) on better classifications of aquatic plant habitats for fish; and 5) cooperative studies among fishery biologists, aquatic plant managers, aquatic ecologists, botanists and limnologists.

BIOLOGICAL CONTROL AND INTEGRATED MANAGEMENT OF PADDY AND AQUATIC WEEDS IN ASIA, Proceedings of International Symposium held in Tsukuba Science City, Japan, October 20-23, 1992. 442 pp.
(Order from H. Shibayama, Chief of Paddy Weed Laboratory, National Agriculture Research Center, Kannondai, Tsukuba, 305 JAPAN.)

This Proceedings includes 23 papers in six subject areas. They include country reports on integrated weed management, the status and prospects of biological controls, integrated control and allelopathy and "bioherbicides".

Included are interesting papers about aquatic plants that produce chemicals that can kill fish as well as plants (J. Harada, pp. 321-333), and about the search for pathogens to kill one of the worst paddy weeds, *Eleocharis kuroguwai* (H. Tanaka et al., pp. 381-392).

The symposium was co-sponsored by the National Agriculture Research Center, Tsukuba, Japan, and the Food and Fertilizer Technology Center, Taipei, Taiwan.

THOMSON'S ENGLISH/SPANISH SPANISH/ENGLISH ILLUSTRATED AGRICULTURAL DICTIONARY by R.P. Rice, Jr., 1993. 160 pp.
(Order from Thomson Publications, P.O. Box 9335, Fresno, CA 93791, (209/435-2163). US$27.95 plus handling.)

This dictionary is devoted exclusively to agricultural, botanical and horticultural terms and names for livestock, equipment, tools, weeds, diseases and insects. All are listed in Spanish and English; a few are illustrated.

PLANTES VASCULAIRES SUSCEPTIBLES D'ETRE DESIGNEES MENACEES OU VULNERABLES AU QUEBEC by G. Lavoi, 1992. 180 pp.
(Order from Ministere de L'Environnement, Direction de la Conservation et du Patrimoine Ecologique, Division de la Diversite Biologique, Quebec. Envirodoq EN910479.)

This report identifies 374 vascular plants of Quebec that are designated either "threatened" or "vulnerable". Quebec law defines "threatened" as "any species whose disappearance is likely" and "vulnerable" as "any species whose survival is precarious". The report includes the criteria used in listing species.

Of the listed plants, at least 50 are wetland or aquatic.

POTENTIAL USE OF NATIVE AQUATIC PLANTS FOR LONG-TERM CONTROL OF PROBLEM AQUATIC PLANTS IN GUNTERSVILLE RESERVOIR, ALABAMA. REPORT 1, ESTABLISHING NATIVE PLANTS by R.D. Doyle and R.M. Smart, Environmental Laboratory, Vicksburg, Mississippi. Technical Report A-93-6. 1993. 66 pp.
(Order from USAE Waterways Experiment Station, 3909 Halls Ferry Road, Vicksburg, MS 39180-6199. Technical Report A-93-6.)

This report is about the attempt to prevent or delay the regrowth of the nuisance plants *Myriophyllum spicatum,*

Hydrilla verticillata and *Lyngbya wollei* in littoral zones of Guntersville Reservoir, Alabama, by establishing populations of native plants.

From these tests, the researchers drew two conclusions: 1) fenced exclosures to protect the newly-establishing native plants from turtles and other herbivores is an "absolute necessity"; and 2) three plant species had the morphological characteristics that enabled them to grow in floating mats of *Lyngbya*: *Potamogeton nodosus, Nelumbo lutea* and *Pontederia cordata.*

CONTROL OF AFRICA'S FLOATING WATER WEEDS, Proceedings of a Workshop Held in Zimbabwe, June 1991, edited by A. Greathead and P. de Groot, Commonwealth Science Council, London. Series Number CSC(93)AGR-18, Proceedings 295. 1993. 187 pp.
(Order from Commonwealth Science Council, Marlborough House, Pall Mall, London SW1Y 5HX, United Kingdom.)

According to the editors, aquatic weeds are found throughout Africa, causing acute problems to human health and livelihoods and causing severe damage to the environment.

In many areas, "waterways are the only means of traveling to the market, hospital or school" and many hundreds of thousands rely on fishing for their livelihoods. Three floating weeds are mainly responsible for shutting down the waterways and fishing grounds, even causing entire communities to relocate to uninfested areas.

"But despite the increasing enormity of the waterweed problems, too often they remain unrecognised or forgotten."

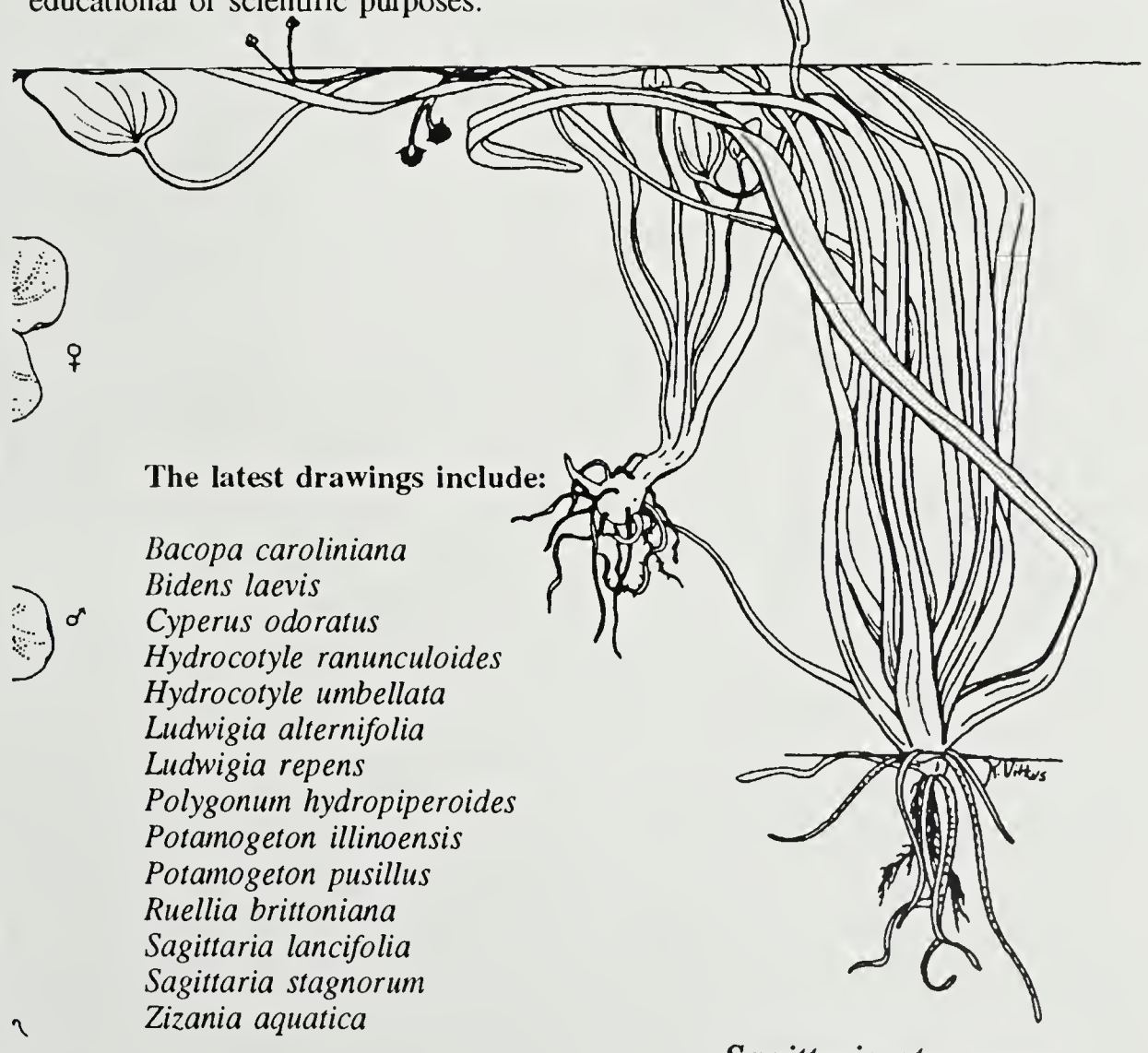
This collection of 22 papers deal with aquatic weed problems of Zimbabwe, Botswana, Malawi, Uganda, Nigeria, Ghana, Benin and other African countries. The three plants most responsible for the misery are water hyacinth (*Eichhornia crassipes*), water fern (*Salvinia molesta*) and water lettuce (*Pistia stratiotes*).

This report includes a recommendations section which specifies action needed on local, regional and national levels.

A newly published Chinese-language edition of C.D.K. Cook's **Aquatic Plant Book** is now available. It may be ordered from Wuhan University Press, Luojiashan, Wuchang, Hubei 430072, PEOPLES REPUBLIC OF CHINA, phone 723187-027.

MORE Aquatic Plant Drawings

Large format line drawings of an additional 14 plants are available from the APIRS office. They are provided free of charge, and may be used for educational or scientific purposes.



The latest drawings include:

Bacopa caroliniana
Bidens laevis
Cyperus odoratus
Hydrocotyle ranunculoides
Hydrocotyle umbellata
Ludwigia alternifolia
Ludwigia repens
Polygonum hydropiperoides
Potamogeton illinoensis
Potamogeton pusillus
Ruellia brittoniana
Sagittaria lancifolia
Sagittaria stagnorum
Zizania aquatica

Sagittaria stagnorum

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AQUAPHYTE

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Karen Brown

AQUAPHYTE is sent to 5,000 managers, researchers and agencies in 87 countries. Comments, announcements, news items and other information relevant to aquatic plant research are solicited.

Inclusion in *AQUAPHYTE* does not constitute endorsement, nor does exclusion represent criticism, of any item, organization, individual, or institution by the University of Florida.

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Milfoil and Lake Titicaca, Bolivia

Among other research, Dr. Mark Brenner (Assistant-In Paleolimnology, Department of Fisheries and Aquatic Sciences, University of Florida) studies lake sediment cores in Central and South America in order to reconstruct paleoclimate and historic and prehistoric human impacts on lake watersheds. In doing so, Brenner also has observed extensive use of aquatic plants in the daily lives of local peoples.

Here in the Bolivian Altiplano on the high and dry shores of Lake Titicaca, water milfoil (*Myriophyllum elatinoides*) is harvested as food for livestock. The huge lake sits at an altitude of 12,500 feet (3,180 meters) and is the highest navigable lake in the world. *Elodea* and *Potamogeton* species also are used to feed domestic animals. *Schoenoplectus tatora* is grown and harvested to construct reed boats. *Azolla* grows abundantly in canals between raised agricultural fields and is used as fertilizer.